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THE JOHNS HOPKINS HOSPITAL REPORTS

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JOHNS HOPKINS HOSPITAL

REPORTS

VOLUME XIX

BALTIMORE
THE JOHNS HOPKINS PRESS
1920

157757
17/12/20

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The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

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THE STRUCTURE OF NORMAL FIBERS OF PURKINJE IN THE ADULT HUMAN HEART AND THEIR PATHOLOGICAL ALTERATION IN SYPHILITIC MYOCARDITIS

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I. INTRODUCTION

Early in 1917 we received from Dr. Edward P. Carter the heart of a syphilitic man 42 years of age. The patient had succumbed to cardiac trouble, showing the characteristic clinical symptoms of atrial fibrillation in the course of chronic myocarditis associated with bizarre *aberrant* electrocardiograms. The fixation of this material received within an hour of the death of the patient was carried out under most favorable conditions. The histological examination of the preparations revealed profound pathological changes in the atrio-ventricular bundle. But in order to interpret with certainty the nature and extent of the alterations it was necessary to compare these preparations with others from the normal heart of a man of about the same age. Such material was furnished to us some weeks later by Dr. Carter. One of his patients, a strong vigorous man of 36 years, in whom all possibility of heart disease could be excluded, died of pneumonia. An autopsy was performed immediately after death and the heart received in the laboratory while still warm.

We have then two perfectly fresh hearts belonging to men of practically the same age, the one pathological and the other normal. We propose here to set forth all the observations which we have been able to make upon this valuable material.

It would have been interesting, had it been possible, to study the evolution of the fibers of Purkinje from the earliest embryonic stages up to the age of 70 to 80 years, but at present we have not the necessary material. Nevertheless we are able to present certain new facts in the morphological study of the fibers of Purkinje in the adult. These facts also permit us to evaluate correctly the pathological alterations in the diseased specimen.

The fibers of Purkinje have been made the subject of many researches. But the evolution of the constituent parts of the atrio-ventricular bundle in man is relatively little understood. Marceau (1902) has published an excellent work upon the development of the Purkinje fibers in the sheep, both in embryonic stages and in young and adult subjects. But it is obvious that the stage of evolution of this element in a sheep of two years (plainly an adult) is not to be compared with that in a child of the same age. Tawara (1906) has published interesting observations upon the heart of mammals and upon a series of human hearts, embryo, child and adult. One must insist upon the absolute necessity of comparing the structure of the pathological bundle with that of the normal bundle at the same age. Some authors have had at their disposal abundant material. Thus Mönckeberg (1908) was able to utilize the hearts of numerous embryos, children, adults and old persons and also 70 pathological hearts, but gave scant attention to the description of a fiber of Purkinje as described in the text-books of histology. In describing the muscular fibers of the atrio-ventricular bundle he speaks of nuclei situated "in zentralen-röhren-förmigen Vakuolbildungen," of fibers of Purkinje "auf weite Strecken hohl" and of others with "nur schmale ovale Hohlräume," of "Hohlfasern," of "soliden Fasern" and of "einzelne Faser teils hohl, teils solid." Descriptions of this character serve to obscure the problem rather than to clarify it.

In the following account one of us (T. W. T.) is responsible only for the description of gross morbid anatomy and for the rendering of the English text. The senior author (O. V. d. S.) has conducted the entire histological investigation and is responsible for the observations made and the conclusions reached.

II. POST-MORTEM EXAMINATION OF HEARTS

Heart 1 was received from Dr. Carter in February, 1917. It was still warm upon arrival and the gross examination was made at once in the laboratory.

The heart is that of a colored male patient (S. S.) of 42 years. The weight of the organ is 770 gm. It is much enlarged: the length from root of pulmonary artery to apex is 125 mm. The amount of fat is not increased. There are large "milk spots" on both ventricles. The pericardium is normal. The right and left atria are large and their walls thick, but neither shows the marked enlargement and hypertrophy

apparent in the ventricles. The right wall of the right atrium at the lower end of the crista terminalis measures 5 mm. in thickness; that of the left atrium immediately above the orifices of the pulmonary veins is also 5 mm. thick. The actual muscular wall of the right ventricle (not including any of the prominent trabeculæ carneæ) between the papillary muscles is 6.5 mm. in thickness and the diameter of the wall of the left ventricle in a corresponding situation measures 16 mm. Near the atrio-ventricular junction the cross-section of the right ventricular wall is 7 mm. and that of the left ventricle 20 mm. There is no apparent endocarditis. The cusps of all four valves are free and normal. The right atrio-ventricular orifice admits four fingers: into the left the entire five can be passed as far as the proximal interphalangeal joint. The orifices of both coronary arteries are surrounded by atheromatous patches which are also numerous in the commencement of the aorta. There is marked enlargement of the ventricular trabeculæ and papillary muscles.

On opening the right side a well-marked pars membranacea septi is to be observed, in the lower margin of which the bundle can be fairly well seen. Immediately in front of the fibrous septum there is marked cicatrization along the course of the bundle, which can be identified under the endocardium right into the moderator band and so to the anterior papillary muscle. In the right atrium strands of Purkinje fibers are visible upon the septal wall, passing from the upper part of the crista toward the atrio-ventricular junction. Similar bands terminating in the same location can be seen running from the region of the coronary orifice. Blocks of tissue about 10 mm. square and 5 mm. thick were cut from the several areas recorded below. In removing such blocks of tissue it is sometimes difficult to be sure that the Purkinje fibers have been included, especially if they lie deeply in the myocardium. If the cut edge of the block be examined promptly, however, the retraction of the Purkinje bundles, always greater than that of myocardial fibers in the perfectly fresh organ, brings about a localized dimpling of the cut surface which immediately sets all doubts at rest. In this part we were particularly fortunate in observing the dimpling in every piece removed except in Nos. 4 and 5 where much cicatrization had occurred.

On opening the left ventricle the bundles show less definitely. The anterior and middle limbs immediately disappear among the unusually marked trabeculæ and no attempt was made to secure these. The

posterior branch is plainly visible in its course toward the posterior papillary muscle and portions of it were obtained as stated below. No histological examination was made of the left atrium.

In referring to the cusps of the aortic valve we shall not employ the usual terms, but adopt Keith's method of calling them right coronary, left coronary and non-coronary, respectively, in reference to the particular artery which arises above each.

The branches of the coronary vessels in the atrio-ventricular junction and those passing along the main branches of the Purkinje system are not obvious to the naked eye in this heart.

After the tissue blocks had been removed from the heart the entire organ was photographed (Figs. 64, 65) and then preserved by the Kaiserling method.

The following is a list of the sites from which tissue blocks were removed in Heart 1:

RIGHT VENTRICLE AND ATRIUM

Piece 1. Moderator band (trabecula supraventricularis) near base of anterior papillary muscle.

Piece 2. Anterior papillary muscle at site of entrance of moderator band.

Piece 3. Right branch of bundle on septal wall proximal to moderator band.

Piece 4. Stem of bundle under endocardium of right ventricle beneath septal cusp of tricuspid valve. This portion includes the commencement of the right and left main branches. It shows marked cicatrization.

Piece 5. Pars membranacea septi immediately above and behind Piece 4, but unlike the latter, which is from the interventricular part of the septum, this is from the septum between the right atrium and the left ventricle.

Piece 6. Tissue of the coronary groove of the right atrium immediately above and including the margin of the orifice of the coronary sinus.

Piece 7. Part of the septal wall of the right atrium immediately adjacent to the non-coronary cusp of the aortic valve.

Piece 13. Piece of ventral wall of right ventricle for myocardial fibers.

Piece 14. Interatrial septum between coronary orifice and fossa ovalis including the margin of the latter. This block is from the wall above and behind Piece 6.

Piece 15. Block from right atrial wall adjoining the orifice of the superior vena cava and including the upper extremity of the crista terminalis and the muscular ring at the junction between atrial canal and atrial appendix. From this block Pieces 16 and 17 were divided off.

LEFT VENTRICLE

Piece 8. Left branch of the atrio-ventricular bundle immediately below the right coronary cusp of the aortic valve before the bundle has broken up into its three left constituent limbs. This block contains the bundle where it first appears under the endocardium of the left ventricle.

Piece 9. Left posterior branch of the bundle in the septal wall. This was the only branch visible to the naked eye in the left ventricle of this heart.

Piece 10. Continuation of left posterior branch passing among the trabecular tissue between septal wall and posterior papillary muscle.

Piece 11. Base of the posterior papillary muscle at its point of union with the trabecula containing the left posterior branch of the bundle.

Piece 12. Block from the ventricular wall at the base of the anterior papillary muscle for myocardial fibers.

Heart 2 was received from Dr. Carter on April 10, 1917. It was still warm upon arrival and the gross examination was made at once in the laboratory.

The heart is that of a white male (H. T.) of 36 years, who succumbed to an attack of acute pneumonia. The weight of the organ is 240 gm. It is of normal size and appearance. The length from root of pulmonary artery to apex is 97 mm. There is a considerable but not abnormal amount of fat. Several "milk spots" are visible on both ventricles. The pericardium is normal. The right and left atria are of normal size. The wall of the right atrium at the lower end of the crista measures 4 mm. in thickness: that of the left atrium immediately above the orifices of the pulmonary valves is 3 mm. thick. The actual wall of the right ventricle between the papillary muscles is 6 mm. in thickness, but at least half of this is fat. The diameter of the wall of the left ventricle in a corresponding situation is 11 mm., only about

1 mm. of this being due to fat. Near the atrio-ventricular junction the cross-section of the right ventricular wall is 12 mm., 4 mm. of this being fat, and that of the left ventricle 11.5 mm. (all muscle). There is no apparent endocarditis. All the orifices and valvular cusps in this heart are of normal size and appearance. The orifices of the coronary arteries are normal and there is no atheroma of the aorta.

On opening the right side the Purkinje system is much less plainly seen than in Heart 1 and the right ventricular bundle is deeply embedded in the myocardial tissue. There is no pars membranacea septi. Blocks of tissue were taken according to the method adopted in Heart 1, as indicated below, and in most of these the Purkinje systems were identified by naked eye examination of the cut surface.

As in Heart 1 blocks of tissue were removed from the main left ventricular bundle and from its posterior branch.

The arterial circle at the right atrio-ventricular junction is plainly marked, the vessels being normal in thickness and in the appearance of the walls.

After the tissue blocks had been removed, the heart was preserved by the Kaiserling method. No photographs were taken.

The following is a list of the sites from which tissue blocks were removed in Heart 2:

RIGHT VENTRICLE AND ATRIUM

Piece 1. Moderator band (as in Heart 1).

Piece 2. Anterior papillary muscle (as in Heart 1).

Piece 3. Right branch of bundle (as in Heart 1).

Pieces 4, 5. Atrio-ventricular septum crossing right atrio-ventricular junction and including tissue corresponding to Pieces 4 and 5 of Heart 1. There is no pars membranacea septi in this heart.

Pieces 6, 14. Only one block of tissue was taken from the right atrial wall above the coronary orifice: it corresponds more to Piece 14 than to Piece 6 in Heart 1.

Piece 7. Part of the septal wall of the right atrium (as in Heart 1).

Piece 13. Ventral wall of right ventricle (as in Heart 1).

Piece 14. See above under Piece 6.

Piece 15. Right atrial wall adjoining orifice of superior vena cava and including the upper extremity of the crista terminalis (as in Heart 1). This piece was not subdivided as in Heart 1.

LEFT VENTRICLE

Piece 8. Left branch of the atrio-ventricular bundle immediately below the right coronary cusp of the aortic valve at the point where the bundle is breaking up into its three left constituent limbs. The piece corresponds to Piece 8 of Heart 1, except that it does not include, in all probability, the most anterior Purkinje fibers.

Piece 9. Left posterior branch of the bundle in the septal wall. This was the only branch visible to the naked eye in the left ventricle of this heart.

Piece 10. Continuation of left posterior branch (as in Heart 1).

Piece 11. Base of the posterior papillary muscle (as in Heart 1).

Piece 12. Block from the ventricular wall at the base of the anterior papillary muscle (as in Heart 1).

III. METHODS

We removed from both pathological and normal hearts pieces of the atrio-ventricular bundle at different levels. Each of these was numbered and Figs. 66 and 67 show the precise situations from which they were removed. Nos. 1, 2, 3, 4, 5, from the right ventricle; Nos. 6, 7, 14, 15, 16, from the right atrium; Nos. 8, 9, 10, 11, from the left ventricle; Nos. 12 and 13 are pieces of the myocardium for comparison with the cardiac tissue surrounding the atrio-ventricular bundle.

Each piece from the pathological heart has been cut into halves at right angles to the bundle. One of these in each instance was immersed in an osmic acid fixative, Flemming's or Hermann's solution, and the other in a non-osmic solution, Bouin's fluid or a 5% aqueous solution of trichloracetic acid.

The pieces of the normal heart were not subdivided: they were fixed entire either in an osmic acid solution or in a reagent of the second type. The period of fixation was one week for Flemming's solution, two days for Hermann's, 24 hours for Bouin's fluid and for trichloracetic acid. Pieces fixed in the two last-mentioned reagents were hardened in 70% alcohol, to which were added a few drops of tincture of iodine which is an excellent mordant for final staining. Before embedding in paraffin they were colored *en bloc* with borax carmine.

After embedding the pieces were cut in part at right angles to the axis of the atrio-ventricular bundle and in part tangential to the endocardial surface. These last preparations present many advantages and frequently show the beautifully plexiform arrangement of the Purkinje cells.

For staining reagents the following methods were used: After fixation with Bouin's fluid or trichloracetic acid one series of sections was colored with iron hæmatoxylin and Congo red, another by Mallory's method. Sections fixed in osmic reagents were stained, some with safranin and light green, others with iron hæmatoxylin and Congo red and others again by Mallory's method.

All the figures reproduced (Plates 1 to 12) represent photographs taken with the Bausch and Lomb Photomicrographic Camera G1. It would have been preferable to use colored figures in order to simplify description and to bring out more clearly the difference in appearance of the constituent parts of the muscular elements and the interstitial connective tissue. It is often difficult to appreciate in a photograph what belongs to the Purkinje cell and what should be considered as endomysium or perimysium. These features, however, are perfectly clear in the preparations. We shall attempt to remedy this defect, at least in part, by indicating precisely the elements most important from the point of view of our description. Photography on the other hand offers a very great advantage, in that it reproduces faithfully and much better than any drawing the morphological appearance of the different varieties of Purkinje fibers, some more or less embryonic in type, some more advanced in their evolution representing stages of transition towards cardiac fibers, and also of myocardial fibers properly so called.

We do not intend to describe the topography of the atrio-ventricular bundle, but shall content ourselves with making a histological study of Purkinje fibers in the normal heart, emphasizing the different stages in their evolution and the characters in which they differ from cardiac fibers at various levels of the atrio-ventricular bundle. By this study we shall be able to determine that in the pathological heart the Purkinje cells undergo an identical evolution carried, however, to pathological excess even to the point of atrophy and complete disappearance.

In order to avoid minute description of different parts of the atrio-ventricular bundle we give a tabular summary indicating approximately the thickness of the endocardium, the existence of smooth muscular fibers in its substance, the diameter of the cells of Purkinje, their tendency to form meshworks or cellular plexuses, the occurrence of intercalated discs, the thickness of the perimysium and endomysium and the degree of interstitial inflammation in the pathological heart.

TABULAR SUMMARY

A. NORMAL HEART (2)

Piece	Endocardium		Cells and Fibers of Purkinje			
	Thickness	Smooth fibers	Transverse diameter	Plexus	Intercal. discs	Perimysium, Endomysium
1	Thin.	Few.	Considerable.	Present.	Visible.	Thin.
2	Thin.	Isolated bundles.	Medium and thin.	Present.	Visible.	Thin.
3	Thin.	None.	Medium and thin.	Present.	Visible.	Thin.
4	Thin.	More or less continuous layer.	Considerable.	Plexus of cardiac cells.	Visible.	Thin.
5	Thin.	As in 4.	Considerable.	Whorls and plexus.	Very plain.	Thin.
6	Thick.	Two layers in places.	Medium.	Present.	Very plain.	Thin.
7	Thick.	Few.	Medium.	Present.	Very plain.	Thin.
8	Medium.	More or less continuous layer and isolated bundles.	Thick, medium and thin.	Whorls and plexus.	Very plain.	Slightly thickened.
9	Thin.	Few.	Thick, medium and thin.	None.	Very plain.	Thin.
10	Thin.	Few.	Thick and medium.	Present, partly cardiac and partly Purkinje cells.	Very plain.	Thin.
11	Medium.	Few.	Thick and medium.	Present.	Very plain.	Thin.
15	Medium.	Two layers in places.	Thin and medium.	Present.	Visible.	Thin.

B. PATHOLOGICAL HEART (1)

Piece	Endocardium		Cells and Fibers of Purkinje				Inflammation in the atrio-ventricular bundle
	Thickness	Smooth fibers	Transverse diameter	Plexus	Intercal. discs	Perimysium, Endomysium	
1	Medium.	None.	Thick, medium and thin.	None.	None.	Thick.	Diffuse.
2	Thin.	None.	As in 1.	Present.	Visible.	Thick.	Diffuse.
3	Medium.	None.	Some thick, more medium and thin.	Present with some whorls.	Visible.	Thick.	None.
4	Thin and thick.	None.	Trunk: Some medium, others thin; lateral bundles: thick, medium, thin.	None.	Visible.	Thick.	None.
5	Thin and thick.	None.	Most thick, some medium and thin; trunk (node): some medium, others very thin.	Present, partly cardiac and partly Purkinje cells. Whorls.	Visible.	Thick.	Slight.
6	Medium and thick.	Isolated bundles.	Medium and thin.	None.	None.	Slightly thickened.	Slight.
7	Thin and medium.	None.	Medium and thin.	Present.	None.	Thick.	None.
8	Medium.	Isolated bundles.	Medium and thin.	Present.	Very plain.	Thick.	Diffuse.
9	Medium.	None.	Medium and thin.	Present.	Very plain.	Very thick.	Well marked.
10	Medium.	Isolated bundles.	Thick, medium and thin.	Present.	Very plain.	Very thick.	Well marked.
11	Thick.	Isolated bundles.	Thick, medium and thin.	None.	Very plain.	Very thick.	Well marked.
14	Thick.	Isolated bundles.	Thick, medium and thin.	Present.	Visible.	Thick.	Slight.
15	Thin and medium.	Isolated bundles.	Medium and thin.	Purkinje plexus; cardiac plexus.	None.	Slightly thickened.	Slight.
16	Thin and thick.	Isolated bundles.	Medium and thin.	None.	None.	Slightly thickened.	None.

IV. BIBLIOGRAPHY

In 1839 and 1845 Purkinje discovered in the heart musculature the cells which still bear his name, but he did not observe them in man. Since this time several authors, among them Aeby (1862), Obermeier (1866), Lehnert (1868), Frish (1869), Krause (1876), Duval (1897), Minervi (1899), and Hofmann (1902) have denied their existence in the human heart. Indeed in 1907 Fahr affirmed that in the human embryo there is no difference in structure between the constituent parts of the atrio-ventricular bundle and those of the myocardium.

Most histological text-books, especially those of France and Germany, state that Purkinje fibers are absent from the human heart. This statement is undoubtedly based upon the negative findings of the foregoing authors and ignores the positive results of others, notably Schweigger-Seidel (1871), Henle (1876), Gegenbauer (1877), and Romiti.

To Tawara (1906) belongs the credit for demonstrating in the heart of the sheep, the dog and man, that the bundle of His divides into two ventricular branches, right and left, which are continuous with fibers of Purkinje in the terminal expansions of the atrio-ventricular bundle. Although this author demonstrates marked differences in structure between cells everywhere in the bundle and myocardial cells, he reserves the term fibers of Purkinje specially for those constituent parts of the terminal expansions in the heart of the sheep. Since this time the majority of authors have followed Tawara's example, but give the name "fibers of Purkinje," however, to the fibers of the terminal expansions in the mammalian and in the human heart. They designate as muscular fibers the constituent parts of other segments of the bundle, especially of its atrial part, of the stem and of its two branches. We shall term cells and fibers of Purkinje the muscular elements of the entire atrio-ventricular bundle.

Through numerous published investigations one is enabled to recognize the essential morphological characters of the Purkinje cells in the hearts of adult mammals. They are bulky, of polyhedral or prismatic shape, and are massed together to form the bands known as Purkinje fibers. Ranvier (1876) has shown that they are united to each other by a scanty intercellular cement which is soluble in a 40% caustic potash solution and is stained black by silver nitrate.

Marceau (1902) differentiates in the sheep three varieties of Purkinje cells according to their shape.

1. Spherical or polyhedral elements. This type of cell is polyhedral near the axis of the muscular bundle and spherical near its periphery. They measure from 20 to 100 μ in diameter.

2. Irregularly polyhedral cells situated in the center of the bundle.

3. Fusiform cells in the finer fibers which are continuous with the cardiac fibers. These cells measure 80 to 150 μ in length and 15 to 35 μ in diameter.

According to all authors, even the earliest, v. Hessling (1854), Eberth (1866), Obermeier (1867), Schweigger-Seidel (1871), Ranvier (1876), the elements are polynuclear. Marceau found in them one or two nuclei as a rule and, when two were present, they were ovoid and close together, or occasionally united to form a single mass. Not rarely one finds three, four, five or even six nuclei of different sizes in one cell. The cytoplasm is represented by a central axial mass, the sarcoplasm or indifferent protoplasm, devoid of contractile fibrils, in which v. Hessling has described fatty and pigment granules. This is surrounded by a more compact peripheral layer variable in thickness, in which appear myofibrils in greater numbers as the embryo or the animal increases in age. These indeed may develop even in the central zone but are much rarer there. Obermeier distinguishes three forms of Purkinje cells:

1. Spheroidal cells with a finely striated cortex and an abundant protoplasm. They contain two or three nuclei.

2. Cells more elongated, with a cortex thicker and more obviously striated and with less abundant protoplasm. Their nuclei are fewer in number.

3. Other cells even more elongated, more slender and with a striated cortex occupying almost the entire thickness of the cell body. These cells are gradually continuous with ordinary cardiac fibers.

Many authors describe the occurrence in Purkinje cells of glycogen droplets. Mönckeberg (1908) attaches great importance to their presence. He affirms that the expansions of the left branch in the heart of the child are continuous with Purkinje fibers, which are very closely similar to neighboring cardiac fibers. The presence of glycogen alone affords a certain criterion for the determination in this part of the atrio-ventricular bundle whether a cell is a Purkinje element or a true cardiac muscle cell. Cardiac cells contain no trace of glycogen.

Marceau (1902) and Schockaert (1909) describe in the Purkinje cell of the sheep four layers:

1. A central zone absolutely unstained, enclosing the nuclei. Hoyer (1901) and Marceau considered this area as an artefact resulting from shrinkage induced by reagents.

2. A granular layer surrounding the foregoing, dotted throughout with rounded granules of variable size and staining intensely with iron hæmatoxylin.

3. A stratum uniformly colored pale grey, in which very fine isolated fibers may be distinguished but of which the transverse striation is scarcely perceptible.

4. A striated cortex formed by bundles of myofibrils arranged in a circular, oblique or longitudinal manner. Schockaert describes certain enigmatic formations in the central sarcoplasm, striated or comb-like plates, to the number of two, three or even more. They are formed by an axial, moniliform or granular rod with a great number of laterally directed filaments each of which passes through one of the axial granules. There is complete agreement among all authors regarding the continuity of the myofibrils across the intercellular spaces and across many cellular areas. According to Lehnert (1868), Frish (1869) and Schmaltz (1886), the Purkinje fibers are represented by two absolutely distinct parts. There is a network formed by fibrils and fibrillar bundles intercrossing in different directions. This network of fibrils is produced by and in continuity with the cardiac fibers. It is independent of a second type of elements, the "granule-cells" or "the granules" which fill the spaces of the network. In the interior of these "grains" myofibrils never appear, according to Schmaltz. These authors have misunderstood the striated cortical layer of the Purkinje cells, yet they have always observed the continuity of the myofibrils passing longitudinally in the fibers described later with greater exactitude by Renaut (1893), Schäfer (1893), v. Ebner (1900), Hoyer (1901), Hofmann (1902), Marceau (1902), Tawara (1906), Mönckeberg (1908), De Witt (1909), Jordan and Banks (1917) and others. Renaut was the first who set himself to follow the exact course of the myofibrils. He distinguishes two systems in the bundles of Purkinje.

1. The superficial system or "feuillets musculaires superficiels" corresponding to Lehnert's enveloping retiform system. These superficial muscular sheets completely surround the peripheral cells of the bundle of Purkinje fibers. The fibrils in these sheets are parallel with each other and with the outline of the cells.

2. The deep system or " feuillets musculaires profonds " independent of the foregoing and represented by muscular columns or sarcostyles parallel with the axis of the bundle. One may follow these from cell to cell without interruption other than the line of intercellular cement. They traverse and intersect the superficial system and the more simple the bundles of Purkinje fibers become the more these sarcostyles increase in importance, while on the other hand the superficial sheets dwindle and disappear.

Marceau distinguishes in a Purkinje bundle, five or six cells in thickness, three varieties of myofibrils at least:

1. The longitudinal muscular layers of Renaut with rectilinear or slightly sinuous fibrils parallel with the axis of the bundle. They are very numerous in the axis itself and diminish in number regularly toward the surface of the bundle.

2. The " feuillets musculaires transversaux " or layers of fibrils arranged at right angles or obliquely toward the axis of the bundle. They intercross with each other and with the longitudinal fibrils. They form loops enveloping either the free surface of cells which bound the bundle or the surface of deeper cells.

3. Isolated fibers whose direction runs in general parallel to the cell outlines. They possess embryonic characters and are destined to be transformed into fibrils of the second variety. Where the bundle becomes thinner and continuous with a bundle of cardiac fibers its constituent cells elongate and become fusiform. The layer of transversely or obliquely arranged fibers atrophies more and more and the longitudinal group increases correspondingly so that in the end all fibrils are oriented as in the cardiac fibers.

Many students of morbid anatomy have described, in the length of the atrio-ventricular bundle, tumors, thromboses, atheromatous alterations, calcareous deposits, gummata or other syphilitic lesions resulting often in alterations not only of the bundle but even of neighboring parts of the myocardium. In this connection reference may be made to the work of Stengel (1905), Aschoff (1906), Barr (1906), Hay and Moore (1906), Jellick, Cooper and Ophüls (1906), Keith and Miller (1906), Keith and Flack (1906), Schmoll (1906), Tawara (1906), Ashton, Norris and Lavenson (1907), Butler (1907), Fahr (1907), Gibson (1907), Vaguez and Esmien (1907), Fahr (1908), Gibson (1908), Heineke, Müller and v. Hösslin (1908), Herxheimer (1908), Löwenstein (1908), Mönckeberg (1908), Saigo (1908), Cohn (1909,

1911), Griffith and Cohn (1910) and others. In the majority of these cases the lesion is accompanied by the formation of more or less abundant connective tissue and even of infiltration by lymphocytes denoting recent or old-standing inflammation which provokes alterations in the muscular portions of the bundle notably their atrophy, necrosis or complete disappearance. Keith and Miller describe a case in which the continuity of the stem of the bundle was completely interrupted in spite of which the Purkinje fibers in the terminal arborization remained intact. Saigo describes an enlargement of the Purkinje fibers from a separation of the myofibrils and a vacuolization of the cell body ending in the disappearance of the transverse striation. Sometimes he has perceived that the vacuolization is accompanied by granular disintegration of the fibrils. At other times the vacuolization, the granular disintegration and the reduction in volume of the fibers are brought about by proliferation of connective tissue, by hemorrhages, by hyaline thrombi or by a proliferation of adipose tissue.

V. PERSONAL INVESTIGATIONS (DESCRIPTIVE)

A. STRUCTURE OF THE ATRIO-VENTRICULAR BUNDLE

If the structure of different segments of the atrio-ventricular bundle be compared, it is apparent that muscular cells of varying appearance exist not only in one part or another but even in the same segment. These differences are due to a gradual and slow evolution of the Purkinje elements which in an adult man, of from 36 to 42 years, attain variable degrees of development. We shall distinguish three successive stages; Purkinje cells which have retained an embryonic appearance, cells of adult aspect, and cells which represent states of transition toward myocardial fibers. Between these three types one encounters every intermediate form.

1. Purkinje Cells of Embryonic Type

These are elements which, having undergone relatively little transformation, recall young or embryonic stages. They are present in greatest number in the normal heart and principally in the ventricular segments (Pieces 11, 8, 5 and 1). Figures 1 and 2 represent them. They are bulky cells, polyhedral or polygonal in section or even prismatic, their longitudinal being a little greater than the transverse diameter.

Towards the center of the protoplasm they show two (np^{II}, Fig. 2), three, four (np^{IV}, Figs. 1 and 2), occasionally five, (np^{V}, Fig. 1) nuclei which are relatively small, oval, of equal size joined together as five or four or even two and two. In the course of evolution they have a tendency to be shifted along the axis or lateral to the axis of the cell body (np^{IV}, Fig. 2).

The cytoplasm is represented by a perinuclear granular zone and a cortical fibrillar area. The central, axial or perinuclear zone is formed by mitochondrial granules arranged in granular filaments or chondriomites (m, Fig. 5), the axis of which is parallel or oblique to that of the cell. Other coarser granules, isolated or heaped together, correspond to pigmentary elements or fatty globules (fg, Figs. 1, 2, 5). All these granules are separated by a paler non-staining substance which in certain preparations is perfectly homogeneous but which in others is formed by a very delicate network, in the meshes of which one sees a pale liquid. This cytoplasmic reticulum is visible along the axial protoplasm in Fig. 5. In the two cells *p* of Fig. 6 it constitutes a very large, clear, perinuclear zone occupying the greater part of the cell body. The mitochondria (m) are quite visible in the neighborhood of the cortical layer: they do not exist at all or are very rare in the clear perinuclear zone which is undoubtedly the perinuclear layer of Schockaert. This clear central zone is equally visible round the two groups of nuclei of the cell np^{IV}, Fig. 2 and of the cell np^{II}, Fig. 1.

In the granular zone one often sees myofibrils isolated or united into very fine bundles. They are transversely striated and make defects in the clear perinuclear zone.

Finally, in certain Purkinje cells of embryonic type there occur in the axis of the cytoplasm one or more bodies of compact appearance and almost homogeneous, staining with Congo red or light green. The significance of these elements we do not know. In transverse sections of the cell these formations resemble an attraction sphere, but in longitudinal sections they often form a kind of axial strand either interrupted or divided into two or three segments (st, Fig. 5).

The cortical or peripheral layer of the cytoplasm is plainly fibrillar. It is formed by dense myofibrils separated by a granular sarcoplasm with abundant mitochondria and is very variable in thickness. Exceedingly thin in the case of cells in Fig. 6 it becomes thicker in Fig. 5, and encroaches upon a great part of the granular zone in the cells of Figs. 1, 2 and 3. Its diameter varies inversely with that of the central zone.

In certain cells, the nuclei of which move laterally from the primitive axis (np^{IV}, Fig. 2; np^{II}, Fig. 4), the myofibrils differentiate in the axial part of the sarcoplasm and produce a mesial partition which subdivides the cell into two symmetrical or asymmetrical parts. As a result of this singular feature the element originally possessing a single axis gradually acquires a dual character and a tendency to reduplicate itself in two parts, each provided with a nucleated and sarcoplasmic axis. Later, in the Purkinje cells of adult type, this double character becomes more manifest. Further on we shall discuss its true significance. It is quite apparent in the Purkinje cell of embryonic type in Fig. 8, an element of very considerable bulk and almost as broad as it is long. In each lateral half there exists a nucleus np^{I} and np^{II} and between these two halves there is a septum of myofibrils, the course of which is irregular.

The myofibrils of the cortical layer and those of the granular zone, the latter, however, being much scantier, are generally grouped in bundles which may be described as muscular columns or sarcostyles, the disposition of which is identical with that of the sarcostyles in the Purkinje cells of adult type, a subject of which we shall speak later. These bundles are separated by a great quantity of sarcoplasm which is much more abundant than in the cells of the myocardium. Although each myofibril, seen in its length, shows a transverse striation as characteristic as that of the cardiac fibers, the longitudinal striation is always much more accentuated than is the transverse. Purkinje cells of adult type present a similarly characteristic structure. Fixed by the methods we have employed the myocardial cells always show a transverse striation much better marked than the longitudinal. Between these two elements there exists a very great difference not only in point of size and form, in number of nuclei, quantity of sarcoplasm and of myofibrils but still more in striation. To appreciate the importance of this morphological character one has merely to compare the cardiac fibers with their very obvious transverse striation (Fig. 7) and the Purkinje cells in which the longitudinal striation is predominant (Plate I). By this comparison we may pick out doubtful forms and particularly the stages transitional between Purkinje fibers and true cardiac fibers. At what age this differentiating character appears in the human heart it is impossible at the outset to determine with the precision desirable for the making of an easy diagnosis between the two types of muscular cell.

Whereas in the myocardium the myofibrils present a very regular arrangement, in the atrio-ventricular bundle, and above all in the interior of many Purkinje cells of embryonic type, this arrangement is more variable. In this connection one can distinguish the following forms:

1. Cells with parallel myofibrils. In these the fibrils are parallel more or less with the axis of the cytoplasmic body (Figs. 1, 2, 5).

2. Cells with intercrossing fibrils. The fibrils decussate in two different directions (df, Figs. 3, 4, 8 and 9).

3. Cells with plexiform fibrils. In these the fibrils intercross in many directions so as to form a fibrillar intracytoplasmic plexus (pl, Figs. 9, 11, 12 and 13). The myofibrils of the second and third categories can propagate the contraction wave in two or more different directions and can communicate it to many neighboring cells. This morphological character is of great importance in the conductive function of the atrio-ventricular bundle. An anatomical basis not less important is represented in two other types of elements the first of which we shall designate by the name intercalated or association-cells and the second, constituted by a group of cells arranged in plexus form, we shall term the cellular network of Purkinje.

4. Intercalated or association cells are interposed either between two longitudinal bundles of Purkinje fibers the axis of which is parallel to that of the atrio-ventricular bundle, or between a longitudinal bundle of Purkinje fibers and a longitudinal bundle of cardiac fibers. They are irregularly polyhedral elements (p and pl, Fig. 11) or cells a little longer than broad (np, Fig. 10; p, Fig. 13). They correspond therefore to Purkinje cells of embryonic type. Their axis is directed at right angles or slightly obliquely to that of the neighboring longitudinal bundles. Some, the simplest ones, possess parallel myofibrils (Fig. 10), others intercrossing or plexiform fibrils (Figs. 11, 13 and 15). But all these fibrils pass uninterruptedly into the cytoplasm of the two longitudinal cells which they connect and in the interior of which they become continuous with the longitudinal fibrils (con, Fig. 10). In the arrangement and the relations of their constituent parts these elements recall somewhat the association neurones in the central nervous system itself which transmit the nervous impulse between different elements of the cerebro-spinal system.

5. The cellular networks of Purkinje are formed by three or more short cells anastomosing to form a network in the spaces of which

there is a vascular connective tissue. It may be that intercalated discs delimit their apposed ends (id, Fig. 12) or sometimes these discs are absent and in that case the network is a real syncytium. In both cases the myofibrils (pl, Fig. 12) decussate in many cellular areas and continue without interruption across the different trabeculæ of the network. These plexuses are very numerous throughout the atrio-ventricular tract in the adult man (see tabular summary). But in the trabecular tissue of the left ventricle (Piece No. 10) of the normal heart one perceives still more complicated appearances, namely, stellate plexiform formations (Fig. 14). Many Purkinje cells embryonic in type, short and broad, are arranged radially about a central plexiform cell (pl). The myofibrils which are arranged almost uniformly in the peripheral cells penetrate into and decussate within the central element whence they continue into the peripheral cells of the opposite side. There exists no demarcation between the central element (pl) and the peripheral cells in this stellate formation.

In his description of the atrio-ventricular bundle in the sheep, in the dog and in man, Tawara (1906) emphasizes the presence of reticular and plexiform appearances. In the heart of the sheep he describes in the atrial portion of the bundle an "ausserordenlich complizierte Netwerk" with very slender fibers, much more slender indeed than those of the neighboring myocardium and of very variable length. The same fiber is in some parts bulky and in others more slender. The myofibrils are less developed than in cardiac fibers and they produce a longitudinal striation, irregular rather than parallel, and a transverse striation which is only slightly apparent. In the spaces of the network one finds fatty tissue with small vessels and nerves. Often four or six fibers bound together produce a stellate formation around a central thick node where the fibrils decussate in all directions.

In the ventricular part of the bundle which commences where the bundle pierces the fibro-cartilaginous atrio-ventricular septum Tawara distinguishes an initial portion (Anfangstheil) and terminal expansions (Endausbreitungen). In the initial portion the bulky muscular cells are united into strands bound together to form a very irregular network, and their fibrils, more numerous than in the terminal expansion, are more or less parallel with the axis of the strand. The coarse fibers of this proximal ventricular segment resemble Purkinje fibers of the terminal portion with which indeed they are continuous, but there are certain quite distinctive features.

In the dog the bundle is formed by elements which are not so definitely distinguishable from myocardial fibers as in the sheep. The atrial part includes an anterior reticular part and a posterior portion with parallel fibers. In the former the fibers compose a close meshwork indistinctly striated transversely with abundant cytoplasm and relatively few myofibrils. They contain isolated nuclei, less frequently two neighboring nuclei and very occasionally even three closely related nuclei. The muscular fibers are in general finer than those of the myocardium but thicker than in the corresponding segment of the sheep's heart. The spaces of the meshwork also are smaller. This network constitutes a node (Knoten) the fibers of which are continuous with the parallel and very slender fibers of the posterior atrial portion. In the latter the longitudinal and transverse striation is less pronounced and the nuclei are more numerous than in myocardial fibers. At the beginning of the first ventricular segment, namely the stem, Tawara finds the same appearances as in the "Knoten," but the meshwork is less complicated and the fibers become more parallel. As in the Knoten the myofibrils run in an irregular course but they are less frequent and more delicate than in the cardiac fibers. They produce a network in the abundant protoplasm. Their course becomes more regular after the trunk has divided up into its two branches.

Tawara summarizes in the following terms his description of the terminal expansions of the atrio-ventricular bundle of the dog (p. 146), "Die Muskelfasern dieses Systems sind fast immer mit einer bindgewebigen Scheide versehen, die viel stärker als das Perimysium der Herzmuskulatur ist . . . . Diese Muskelfasern sind meist aus zahlreichen, hintereinander liegenden, relativ kurzen und breiten Sarkoplasmaterritorien zusammengesetzt und zeigen deshalb in gewissen Abstände sehr deutliche Grenzzonen, während man in den gewöhnlichen Herzmuskelfasern des Hundes wohl Kontraktionslinien, aber keine Grenzzonen finden kann. Als weiteren Unterschied muss man die relativ geringe Zahl und den unregelmässigen Verlauf der Fibrillen und das demgemäss reichlich vorhandene Sarcoplasma der Fasern der Endausbreitungen des Bündels aufzählen. Endlich ist die oben zuletzt erwähnte, höchst komplizierte Fibrillenordnung an den Knotenpunkten der verschiedenen Endausbreitungen so eigenthümlich, dass man ein solches Bild niemals in der gewöhnlichen Herzmuskulatur sehen kann."

Finally, he describes an appearance peculiar to the heart of the dog and found at the level of the terminal ventricular segment where a muscular bundle divides into two or three twigs or where several bundles joining together produce a nodal point (*Knotenpunkt*). At this site, says he, the muscular bundles and the muscular fibers frequently resolve themselves into many small fibrillar groups and partly even into isolated fibrils like the spread out fingers of the hand. These become bound together with other muscular fibers and thus produce a very complex network. (See Tawara's Fig. 10, Plate IV.)

Tawara's description of the human heart is brief. In structure the atrio-ventricular bundle resembles that of the dog. In the atrial part the fibers, which are very slender, form the usual network but the spaces in this are larger. The first part of the ventricular segment presents parallel fibers alone. In the terminal expansions the muscular fibers appear to contain more fibrils than in the dog and for this reason they resemble cardiac fibers more closely. Tawara then draws attention to certain pathological details.

The foregoing summary of the results obtained by Tawara, in great part confirmed in the human heart by Mönckeberg (1908), shows that the former author attributes great importance to the plexiform or retiform arrangement of the constituent parts of the atrio-ventricular bundle. De Witt (1909) adopts the same attitude. In studying the *node* in the sheep, the cow, the dog, the cat and man, he states that the anastomosis of fibers occurs "not by simple fusion of two united branches, as is usual in heart muscle, but by the formation of nodes or star-like forms, into which two or three, or more, fibers become merged and from which a variable number of fibers emerge. In the *node* the fibers completely lose their identity, fibrils from the different fibers commingling confusedly" (p. 491). These fibers are less bulky than the cardiac elements of the atrium. Later in describing the Purkinje fibers of the terminal expansions in the dog, in the cat and in man, De Witt states: "The fibers are very variable in size and nodal points showing a commingling of fibrils from different fibers are frequent." These plexiform appearances are very similar to the features of the Purkinje cells of embryonic type in the human heart described by us above. It is important to observe, however, that in our material these special structures do not present in any segment, even in the atrial node, so marked a generalized character as appears from Tawara's account. From this point of view our Fig. 44 undoubtedly

accords most closely with Tawara's description. It is reproduced at a magnification of 45 diameters and shows a transverse section of the first part of the trunk or perhaps the inferior part of Tawara's Node (Piece 5) in the pathological heart. The muscular elements are represented by Purkinje cells of adult type of which about a third are of medium transverse diameter and a little thicker than those of the neighboring myocardium, while the others (two-thirds of the whole) are very fine and more slender than the cardiac cells. The majority of the bundles or groups of fibers (gr) present a regular disposition parallel with the axis of the atrio-ventricular bundles; some others are arranged obliquely or even in circular fashion relative to this axis and show a tendency to anastomose to form a network. In Fig. 43 which represents a transverse section of the septal wall of the right atrium in the normal heart (Piece 7) the Purkinje fibers of adult type (lp) are of medium diameter: they are a little larger than those of the neighboring myocardium (lc) and are arranged throughout very regularly. But in sections of the same piece (Piece 7) cut tangentially to the surface of the endocardium one observes certain reticular formations not more numerous here, however, than in other segments of the atrio-ventricular bundle. In other atrial portions lying near the orifice of the superior vena cava (Pieces 15 and 16; Figs. 47 and 48), and near the coronary sinus (Pieces 6 and 14; Fig. 51) the Purkinje fibers of adult type are in general of medium thickness or even slender, the former being much thicker than those of the neighboring myocardium. In the trunk (Piece 5) of the normal heart they are thick and also in the two branches (Pieces 4 and 8), although in the left branch (Piece 8) there may be some slender ones and others of medium thickness. In all these segments as in the terminal expansions one can see reticular formations produced by the Purkinje cells of embryonic type, but the great mass of fibers shows in general a parallel arrangement similar to that of the cardiac fibers. These appearances are specially well marked in sections cut tangentially to the endocardial surface.

We may therefore sum up by saying that the Purkinje fibers of the atrio-ventricular bundle in the adult man present in general a regular arrangement, but that in most segments one encounters bulky cells which are of embryonic type, short and polyhedral or a little longer than broad. Some possess myofibrils parallel with the axis of the cytoplasmic body; others exhibit myofibrils decussating in two or more directions and others again group themselves in such a manner as to

produce a plexiform cellular network and occasionally stellate formations. All these features like the intercalated cells give an anatomical basis most favorable for the transmission of the contraction wave in various directions.

In general the Purkinje cells of embryonic type exhibit a very precise delimitation. The polyhedral elements show along some of their surfaces a fine connective tissue, often vascular, a sort of endomysium which separates them from neighboring cells (enm, Figs. 1, 2, 3 and 4). Other surfaces of the polyhedron are delimited from the cytoplasm of adjacent elements by actual intercalated discs (id) absolutely identical with those visible in the length of the cardiac fibers (id, Fig. 7). They are traversed by the myofibrils which are continuous over several cellular areas. Those cells, which are a little longer than broad, exhibit a connecting septum of endomysium on their lateral surfaces (enm, Figs. 8, 9 and 12) and intercalated discs (id) separating their extremities. A photograph does not bring out satisfactorily the difference in appearance between the septa of connective-tissue (enm) and the transverse discs (id), but in the preparations it is easy to distinguish between them. Stained by Mallory's method the former are colored blue and the second red; in preparations stained with safranin and light green the septa are green and the discs red.

This well-marked delimitation of cellular contour is lacking at the extremities of the intercalated cells (Figs. 10, 11, 13 and 15) and at the extremities of certain plexiform figures such as that in Fig. 14.

2. Purkinje Cells of Adult Type

These are elements elongated, cylindrical or, as a result of reciprocal pressure, prismatic or even flattened and, in this case, they are laminated and elongated in transverse section. Often they correspond to half or a third of a cylinder or prism and in such cases they show, on transverse section, a plane surface adjoining the similar surfaces of neighboring cells and thus giving a tessellated appearance (Figs. 21, 22, and 23). This arrangement recalls the appearance resulting from the grouping of cartilage cells three or four together. We shall show that here, as in cartilage, this appearance may be produced by the division of a mother-cell into two, three or four daughter elements.

They form the great mass of the Purkinje fibers in the whole extent of the atrio-ventricular bundle, but they vary in thickness from one

segment to another (see tabular summary). The majority of these elements in the normal heart should be considered as multinuclear cells, real polykaryocytes (Howell). These nuclei are generally equal in size and a little larger than those of the cells of embryonic type; but one sometimes encounters nuclei of very considerable bulk (np, Figs. 24, 33 and 37). The nuclei are rounded or oval and in their morphological characters they more closely resemble the nuclei of the true cardiac elements (nca, Fig. 7) as the cell is more evolved and hence more closely approaches in appearance the cells of the myocardium (Fig. 42). In very rare instances only are all these nuclei noted in a single longitudinal section so that it is difficult to determine their exact number. Especially is this difficult since the nuclei are shifted and may lie quite distant the one from the other. This shifting, active or produced by an extension of intermediary cytoplasma and already indicated in the case of the cells of embryonic type, becomes gradually more marked in both lateral and longitudinal directions. It seems to have attained its extreme limits in Fig. 18. This represents a bulky single cell which we shall call a mother-cell (pm); it is almost isolated on the section in the midst of an abundant vascular connective tissue (v). This last is brilliantly stained with light green, whereas the cell is colored red. Except for a fine green septum (enm) which penetrates a short distance into the extremity of the cell body no trace of division of the protoplasm is visible. This cell encloses five nuclei labeled respectively np^{I}, np^{II}, np^{III}, np^{IV} and np^{V}. Two are situated at one pole of the protoplasm and three at the other. Figs. 17 and 19 show different stages of this gradual shifting of nuclei. In the former one notes to the right a bulky cell although shorter than that in Fig. 18. It encloses two nuclei np^{I}, np^{II}, separated in the axial direction. To the left another cell shows two nuclei np^{I}, np^{II}, withdrawing themselves in the lateral direction and separated by a septum of myofibrils. Fig. 19 shows a mother-cell (pm), in one half of which there is a group of two nuclei (np^{I-II}) and a third (np^{III}) situated a short distance from the others. Figs. 17, 18 and 19 show us, then, stages in growth and elongation of the Purkinje cell accompanied by a removal of the multiple nuclei both laterally and longitudinally.

The cytoplasm is represented by sarcoplasm and myofibrils. The abundance of the former varies inversely with the number of the latter. The sarcoplasm is a pale reticulated substance strewn throughout with mitochondrial (m, Fig. 20), fatty and also pigmentary granules. The

enigmatic axial strand described in Fig. 5 (st) persists in the cells of adult type (st, Fig. 23). In the embryonic type of cell the sarcoplasm produces a perinuclear zone of rounded form or tapering in the axial direction. In elements of adult type it occurs as an axial band in "unipartite" cells (Figs. 17 and 20), as two lateral bands in "bipartite" mother-cells (Fig. 17, left side; pm, Fig. 19) or as three bands in the "tripartite" cells (Fig. 18). The multiple nuclei are distributed in these sarcoplasmic bands, to the opposite poles of which they draw with the advancing evolution of the cell. The bipartite or tripartite cells are often asymmetrical.

At the beginning of these transformations myofibrils are rare in the sarcoplasmic zone, but they become gradually more numerous in definite directions of the large mother-cells. In this manner they produce in the bipartite elements a myofibrillar partition and in the tripartite elements two apparent partitions subdividing the cell body into two (Fig. 19) or three portions (Fig. 17, cell to the left enclosing two nuclei np^{I}, np^{II}). Each part or lobe encloses one or two nuclei. These partitions, as transverse sections show, are often in direct relation with the cortical myofibrillar layer (pt^{II}, Fig. 23) which gradually extends between the two halves of the cell.

In general the Purkinje cells of adult type possess a peripheral cortical layer, the myofibrils of which are much more numerous than those of the axial sarcoplasmic zone. Longitudinal sections show this feature, but it is especially obvious in transverse sections. This is confirmed in the normal heart by Figs. 21 and 22 and in the pathological organ by Figs. 23, 24, 25 and others. But these same photographs also show many cells, the central parts of which are strewn with a large number of myofibrils to such a degree that one can see no delimitation between their two zones. This observation applies to certain Purkinje cells of embryonic type (Figs. 3, 4 and 12) and especially to the Purkinje fibers of adult type in the stem and atrial segments of the bundle (Figs. 22 and 47). This more or less uniform distribution of myofibrils across the whole thickness of the cell body is undoubtedly the morphological character which most strikingly distinguishes the Purkinje cells of the atrium from those of the ventricles. Furthermore, the cells of the ventricle are in general thicker. It is important to observe, however, that in the atrium one may note bulky elements and cells with a quite distinct central sarcoplasmic layer, whereas in the ventricular segments one observes

slender cells and elements with myofibrils uniformly distributed in the whole thickness of the cytoplasm. Differences in volume and in distribution of myofibrils are merely secondary accessory features, which depend upon the stage of evolution in a single type of cell. For this reason we shall consider the muscular elements of all segments of the atrio-ventricular bundle as belonging to a single type—the Purkinje cell. The fundamental character by which one easily distinguishes Purkinje cells of either atrium or ventricle from cardiac elements is the constant presence in much greater abundance of an interfibrillar or inter-fascicular sarcoplasm. This feature gives to the Purkinje cells a quite distinctive, clearer and less compact appearance. The fibers of the myocardium are more deeply stained and are denser. This difference in morphological appearance is visible in all our photographs, even in those reproduced at a low magnification. It can be seen in the ventricular segments (lp and lc, Figs. 26 and 27), the stem (gr, Fig. 44) and its branches (rbr and lc, Fig. 46), in the atrial segments (lp and lc, Figs. 43 and 48) and even where the Purkinje fibers are intermingled with myocardial bundles (lp and lc, Fig. 51). Keith and Flack (1906), among others, have already drawn attention to this difference in appearance and insist upon its physiological importance, it being accepted that pale muscles contract more rapidly than red muscles. We would add that the great abundance of sarcoplasm, together with the presence of a smaller number of myofibrils in the Purkinje elements, constitutes a second distinctive and not less important morphological feature, which relates to the nature of the striation. The longitudinal striation is more pronounced than the transverse in the Purkinje cells, whereas the transverse striation preponderates in the cardiac elements.

Grouping of myofibrils in columns. It is known that the myofibrils of cardiac cells and even of Purkinje cells tend to unite in the midst of the cytoplasm into muscular columns or sarcostyles, between which there exists a sarcoplasm more abundant than between the fibrils of the columns themselves. This arrangement is well marked in all Purkinje cells in the adult man, but the form of the sarcostyle is exceedingly variable from cell to cell and even within a single cell. Columns can be distinguished presenting the form of prisms, rods, or again of hollow cylinders. The prismatic and rod-like columns are made up of a compact bundle of myofibrils, whereas the hollow cylinders are formed by a peripheral myofibrillar sheath surrounding a sarcoplasmic axial por-

tion (Fig. 21, the large cell p). Other columns are laminated and generally occur in the cortical layer of the cell (Fig. 21). In transverse sections they are visible as thick striæ arranged radially in relation to the central sarcoplasm. The striæ may be simple and thick, or double and formed by two fine parallel streaks separated or united in part of their course. This feature seems indeed to indicate a cleavage into two of one primitively single lamella. All these types of columns are found in the pathological heart just as in the normal organ, but in the former their arrangement is much more variable and complicated and often it is related to longitudinal cleavage of the Purkinje cells.

3. Longitudinal Segmentation or Cleavage of Purkinje Cells

M. Heidenhain (1902) has described a process of longitudinal division in myocardial fibers—the segmentation of "mother fibers" into "daughter fibers." This occurs through the appearance of a system of longitudinal clefts which delimit a myofibrillar bundle in relation to a segment of the intercalated disc. These clefts, which are very narrow, are occupied by a clear substance from which all trace of transverse striation is obliterated and in which there appears a simple sarcolemma-like membrane in continuity with the discs Z of neighboring myofibrils. This membrane, which is at first single, doubles itself later into two, the "two daughter sarcolemmata" adherent to the surface of the "daughter fibers." Heidenhain studied this process in sections parallel with the axis of the cardiac fibers, but he does not speak of the appearance seen in transverse sections.

The longitudinal cleavage of Purkinje cells should be studied in transverse as well as in longitudinal sections. It is indeed more marked and better visible in the pathological heart than in the normal organ, but it exists in both throughout the length of the atrio-ventricular bundle.

In transverse sections are seen the three types of cells described above.

1. Cells with a cortical myofibrillar layer and a central sarcoplasmic zone.

2. Cells in which the myofibrils are more or less regularly distributed throughout the whole extent of the cytoplasm.

3. Cells of the subdivided type, bipartite or tripartite. This last really represents the first stage preparatory to longitudinal cleavage. One or two myofibrillar partitions subdivide the mother-cell into two

(pt^{II}, Figs. 21, 23 and 30) or more lobes, more or less symmetrical in size and in structure. At other times, and especially in the pathological heart, these lobes are asymmetrical, in that one half of the protoplasm, closely resembling the cytoplasm of a cardiac cell, contains many more myofibrils than the other half. In Fig. 29 there is a cell (asp) of which the lateral half is clear and the other half very darkly stained. This cell is obviously asymmetrical. The same is true of a mother-cell in Fig. 25 in which an arrangement of partitions (pt^{III}) divides the cell into three parts, one very rich in myofibrils (pc) and two others which differ in size, one of which contains a nucleus (np). In Fig. 24 a partition (pt^{IV}) subdivides the mother-cell into four slightly asymmetrical segments, while the partition pt^{III} divides another cell into three symmetrical segments. In the pathological heart one observes not infrequently the differentiation of the axial cytoplasm to resemble that of a cardiac cell. It is deeply stained (cc, Fig. 23) and distinctly marked off from the peripheral zone, which retains the primitive features characteristic of the Purkinje cell.

In the second stage of cleavage the endomysium surrounding the mother-cell proliferates into the intracytoplasmic myofibrillar partition and subdivides the cell body into two symmetrical daughter-cells (p^{II}, Figs. 22, 25 and 28; pc^{II}, Figs. 22 and 29), into two asymmetrical daughter-cells (asp^{II}, Figs. 23 and 28) or even into three or more asymmetrical elements (asp^{III}, Figs. 22 and 23). Special attention should be given to two bulky mother-cells which are absolutely pathological. The one (pm, Fig. 28) shows the commencement of cleavage into five lobes of very different size by fine partitions of endomysium (enm) in continuity with the thick pericellular endomysium. The other (pm, Fig. 30) has undergone an apparently irregular cleavage in its lateral half.

These intracellular connective-tissue septa originate undoubtedly from an extension of the neighboring endomysium. At the beginning they are thin, but in the pathological heart they may become thick and, when the daughter-cells are completely separated, they may attain a considerable thickness which is characteristic of the following stage.

In the third stage of cleavage, limited exclusively to the pathological heart, the daughter-cells, two or three in number, are separated by a thick connective-tissue partition and even a former cleavage of the mother-cell can be recognized owing to the regularity of the old method of segmentation represented in transverse section by a straight line.

In other words, the cylindrical mother-cell has been subdivided into two half cylinders of which the plane surface of cleavage remains recognizable and characteristic (p^{II}, Fig. 24) and is formed by a thick partition of endomysium. These figures irresistibly recall the similar appearances characteristic of groups of two or four cartilaginous daughter-cells resulting from the mitotic subdivision of a maternal element.

Finally, in a fourth stage, namely that of atrophy of the Purkinje fibers in the pathological heart, the twin cells in their turn undergo a repeated longitudinal cleavage, which induces reduction in their size and later atrophy. One of the two daughter-cells (p^{II}, Fig. 24), which are separated by a thick intercellular partition, shows a tripartite condition (pt^{III}), owing to cytoplasmic differentiation of two thick myofibrillar partitions. A similar differentiation (pt^{III}) may be observed in one of the two daughter-cells (p^{II} in Fig. 25). These appearances indicate that twin cells undergo a longitudinal cleavage in their turn. In several regions of the ventricular parts of the atrio-ventricular bundle one finds Purkinje elements much reduced in size as symmetrical (ap^{II}, Figs. 29, 32 and 34; ap^{III}, Fig. 34) or asymmetrical ($asp^{II}a$, $asp^{III}a$, Fig. 32) daughter-cells. These twin elements represent stages in the atrophy which we believe are provoked especially by this process of repeated cleavage. Their transverse diameter scarcely surpasses that of a smooth muscular fiber. Often this atrophy is accompanied by the appearance of a plainly visible internal cytoplasmic membrane. This, differentiated in the midst and at the expense of the protoplasm, separates a clear perinuclear protoplasmic zone free from myofibrils from a fibrillar cortical layer (im, Figs. 32 and 34) of which the sarcostyles or the isolated fibrils always show a transverse striation.

This process may be still more accentuated, the atrophied cells in their turn undergoing a cleavage into smaller elements (ap, Figs. 32 and 34) either isolated or grouped together and representing the last vestiges of Purkinje fibers. In extreme atrophy these vestiges are simply small cytoplasmic masses which may or may not be nucleated and possess a few occasional myofibrils. But from the point of view of function of the atrio-ventricular bundle the majority should be considered as completely devoid of contractility and of the power to conduct the contraction wave.

In order to obtain an exact idea of this atrophic process of the Purkinje elements in the ventricular part of the pathological heart, one

ought to examine not only Figs. 32 and 34, the fibers in which are atrophied, but also Fig. 21 in which the fibers are normal. All three are magnified 476 diameters. In this comparison should be included Figs. 26 and 27 reproduced at a magnification of 85 diameters. The first is a photograph from Piece 10 of the normal heart and the second of Piece 9 of the pathological organ. Fig. 26 shows throughout the whole extent of the Purkinje layer (lp) bulky cells of a uniform diameter, whereas Fig. 27 shows, beside many bulky cells (p), others of medium size and a multitude of others very small and atrophied (ap). Many of these last appear as small clear spots the size of which does not surpass that of one of the lymphocytes which infiltrate the neighboring inflamed interstitial tissue (cti) in large numbers.

Longitudinal sections parallel to the axis of the Purkinje cells show equally plainly different stages of their cleavage in length. These figures are undoubtedly less clear than those seen in transverse sections. They must be analysed, however, to enable us to study the process of proliferation in the septa of the endomysium throughout the entire length of the cytoplasm, and the distribution of the multiple nuclei of the mother-cell in the interior of the daughter-cells.

A first series of figures (Figs. 18 and 17) shows us the arrangement of partitions in a tripartite mother-cell, the former with the nuclei distributed at the poles of the future daughter-cells, the latter with an arrangement of two septa of myofibrils (pt^{III}) subdividing the cytoplasm into three parts. A second series of figures (Figs. 20, 19 and 31) gives us an exact idea of the extension of the endomysial membrane throughout the length of the mother-cell. Fig. 20 shows an element of which one extremity is subdivided into two unequal portions by a septum (enm). In Fig. 19 the septum attains the level of the two cohering nuclei (np^{I-II}); and in Fig. 31 the endomysium (enm) which possesses a blood vessel (cp) divides the mother-cell (pm) almost completely into two equal halves of which the one possesses a simple nucleus (np^{I}) and the other two (np^{II}, np^{III}) a single one at each pole of the future daughter-cell. The arrangement of the nuclei before any trace of cleavage (Fig. 18) and before the completion of longitudinal division (Fig. 31) tends to show that each twin cell encloses two or three nuclei distributed generally at the two cytoplasmic poles.

When segmentation is completed it is difficult, usually impossible indeed, to recognize in longitudinal sections the twin cells produced by the cleavage process. The preparations of the pathological heart,

however, furnish us invariably with another series of figures (Figs. 35 and 36) in which one can recognize a characteristic grouping into two or three daughter-cells. An abundant connective tissue separates the groups one from another; a fine septum of endomysium separates the twin elements from each other within a single group. In Fig. 35 the majority of the daughter-elements are represented by one bulky cell and by another much smaller (p^{II}). In Fig. 36 the interstitial connective-tissue separating the groups is infiltrated by a great number of leucocytes (cti), but the septa of endomysium between the constituent parts of a single group are in general lacking altogether in these inflammatory cells (p^{II}). In this illustration one sees, furthermore, a mother-cell (pm) very bulky and segmented at one of its extremities, besides other groups each of two twin elements (p^{II}), the total transverse diameter of both elements being almost equal to that of the mother-cell.

The longitudinal cleavage of the Purkinje cells in the pathological heart may be accompanied by segmentation phenomena or direct division of the nuclei induced by extension of the proliferating connective-tissue septum. Fig. 24 shows a nucleus (np in the upper part of the figure) formed by two unequal lobes united by a constricted portion. At the opposite side of the illustration (np, in the lower part of the figure) there is visible a nucleus equally lobulated abutting upon a septum of endomysium (enm) which appears to have brought about this irregular form of the nucleus. Longitudinal sections parallel with the axis of the Purkinje cell show appearances more convincing for a decision as to the causative relation of the proliferating connective-tissue to nuclear segmentation. In Fig. 33 one observes a mother-cell partially subdivided into two daughter-elements (p^{II}) by a median septum (enm) of endomysium, pale in the photograph but colored blue in the preparation which is stained by Mallory's method. This septum indents the bulky nucleus (np), thus forming two lateral nuclear lobes, one lobe for each future daughter-cell. In Fig. 37 the nucleus (np) has been almost entirely pinched into two halves by the septum (enm), which though pale in the photograph is clearly stained blue in the preparation. It separates also in part the mother-cell into two twin cells, p^{I} and p^{II}. These two last figures leave no doubt as to the influence of the invading connective-tissue upon the process of amitotic division of the mother-nucleus.

We have already noted the presence of blood capillaries in the interior of endomysial septa which provoke the cleavage of mother-cells (cp, Fig. 31). Fig. 38 shows another example of this in the atrial segment (Piece 6) of the pathological heart. In this may be seen an element with a rounded nucleus (np) surrounded by a clear granular sarcoplasm with numerous pigmentary granules (pig). It is partly subdivided into two (p^{I}, p^{II}) by a connective-tissue septum (enm) stained green in the preparation. This septum reaches the perinuclear sarcoplasmic region and contains as far as its most advanced point a blood capillary (cp) in which are visible the central lumen and the endothelial wall in which there is a nucleus. This figure shows that the septum of cleavage not only can include capillaries but even that the capillary precedes and appears to direct the connective-tissue in its invasion of the cell. The phenomenon is comparable to that observed in the vascular osteogenic buds which penetrate into the centers of ossification of a bone at the time of resorption of the calcified cartilage.

All the figures described so far tend to prove that the vascular endomysium invading the cytoplasm of a mother-cell occurs as a septum dividing into two parts the extremity of the cytoplasm. Fig. 39 shows a Purkinje cell cut transversely at the level of one of its nuclei (np). At the center of the sarcoplasm is seen a blood capillary (cp) filled with red corpuscles (rc) quite comparable with those shown in a neighboring capillary (rc). This figure proves that the invading tissue may sometimes assume the form not of a septum but of a rounded cord or at least a kind of vascularized papilla following the axis of the cylindrical cell. Jordan and Banks (1917) draw attention to a similar feature in their Fig. 42 where "an artery appears to be within the cell. This definitive condition is probably the result of a secondary adaptation of the cell to the growing bloodvessel" (p. 305). From the above description it follows that the Purkinje cells of the normal heart possess quite a special morphology. No other tissue shows stages so varied as regards the distribution of the nuclei, the transformation from a unipartite element into a bipartite or multipartite element, or the consequent division of the cell body. These stages really represent a series of successive phases which terminate in the longitudinal cleavage of a mother-cell into smaller and simpler daughter-cells. The subdivision is provoked or at least accompanied by a proliferation and extension of the neighboring vascular perimysium.

In the pathological heart the cleavage process is much more pronounced than in the normal organ. It becomes pathological undoubt-

edly under the influence of the etiologic factor syphilis which has induced hypertrophy and sclerosis of interstitial connective-tissue in the atrio-ventricular bundle. This supporting tissue, developed abnormally, exercises an abnormal influence on the evolution of neighboring muscular elements. Many Purkinje cells preserve a normal appearance, but others undergo an exaggerated cleavage more or less pathological, whereas others again divide and subdivide until they are reduced to the condition of atrophic cells in process of complete disappearance. These pathological conditions of atrophy and sclerosis are brought about by two factors occurring certainly in the normal heart but of exaggerated activity in syphilis—the cleavage of the Purkinje cells and the proliferation of the supporting substratum or vascular connective tissue. The Purkinje cells already reduced in size by repeated division are subjected to the detrimental influence of the hypertrophied interstitial tissue. This constricts them, hastens their atrophy and in certain places provokes their complete disappearance. We shall return later to this question.

It is very important from the biological standpoint to know if the division of the Purkinje cells should be interpreted as mitotic or amitotic. We are not able to solve this problem, for it would need to be studied in large part upon embryonic material. The multiple nuclei described in these elements are already formed before or shortly after birth. To solve adequately the problem just stated it would be necessary to know how these nuclei are produced. It is doubtful whether they appear as the result of an indirect division or of a direct division. In the case of myocardial fibers Tangl (1889), Hoyer (1899), Schockaert (1909) and others have observed figures of mitotic nuclear division in the foetus, and they estimate that at some little time after birth the multiple nuclei of the cardiac cells originate by mitosis. Hoyer denies the direct nuclear division described by Solger (1891) and in 1900 the latter author was obliged to admit that the multiple nuclei are derived in part by indirect division and in part by direct division. Marie Werner (1910) has counted in the cardiac cells of various mammals multiple nuclei up to the number of 32 in a cell from the left ventricle of the pig, and she can find no trace whatsoever of mitotic division. Schockaert describes in detail the stages of mitotic division in the cardiac elements and proves that these behave exactly like uninucleated cells. In the anaphase and in the telophase there occurs between the two daughter-cells a cytoplasmic segmentation marked constantly by the presence of an intermediate corpuscle. In the last

stages myofibrils appear prolonged from one cell into another. The cardiac fibers behave, therefore, in these stages of their development not like a syncytial mass but like uninuclear elements.

If the multiple nuclei of the Purkinje cells are produced as the result of a mitotic process, the longitudinal cleavage described above ought to be considered as a final stage in the indirect cell division occurring in the adult man many years after the nuclear mitosis. A similar tardy cleavage has been described in megakaryocytes of the hemapoietic organs in mammals. Van Bambeke and Van der Stricht (1891) have shown that such giant cells acquire a considerable size in consequence of many repeated multipolar mitoses. Their lobulated nucleus is really constituted therefore by a large number of small daughter-nuclei which fuse during the telophase. But this cell, very important from the physiological point of view, is capable of multiplying, of producing two daughter-megakaryocytes. The division of the mother-cytoplasm is always long retarded; it does not take place until after many repeated multipolar divisions of the maternal nucleus. Finally, when the giant nucleus has attained considerable size, it is broken into two by the appearance of a cellular plaque subdividing the giant mother-cell into two daughter-megakaryocytes. This type of direct division is really the complement of the multimitosis and cannot be regarded as an amitosis.

Our knowledge is very limited regarding the formation of multiple nuclei in the Purkinje cells and the division of these elements. Marceau has been unable to find in their cytoplasm nuclei in process of mitosis, but he describes progressive stages of amitotic division. He concludes with the statement: " Les noyaux des cellules de Purkinje ne se multiplient probablement que par étranglement ou bourgeonnement, suivi de scission " (p. 25), and he adds later, " Cependant, la division du noyau peut être suivie elle-même de la division de la cellule, car j'ai observé des cellules en forme de huit de chiffre renfermant un noyau dans chacune des deux boucles alors que dans la région rétrécie on voyait de très fines fibrilles en voie de développement et destinées à compléter l'écorce des deux cellules-filles ainsi formées. Donc chez l'adulte les cellules de Purkinje conservent certainement la faculté de se diviser " (p. 25). On page 61 he expresses himself in the following terms: " Au moment de la naissance le nombre de fibres cardiaques est à peu près atteint et celles qui existent alors ne font que s'accroître et acquérir leur structure définitive. A la même époque les fibres de

Purkinje sont plus grêles et comprennent en épaisseur moins de cellules que chez l'adulte, ce qui montre que pour arriver à leur complet développement les fibres de Purkinje des jeunes animaur doivent être le siège d'une multiplication cellulaire, multiplication qui se continue même chez l'adulte ainsi que je l'ai observé."

In speaking of the structure of the "atrioventricular connecting bundle" Jordan and Banks (1917) find that the nuclei, "arise chiefly by amitotic division of a single nucleus of the original cell, a process which can be observed in fetal hearts of from two to four months. A few nuclei were observed in the segmented spireme condition in the two-month fetal heart, which would seem to indicate that mitotic division may also occur in the earlier stages. In this respect the bundle simply agrees with ordinary myocardium, where nuclear division is originally mitotic and subsequently becomes exclusively amitotic. The tri- and quadri-nucleated condition of the bundle cells follows a later similar amitotic event" (p. 304). Later they state (p. 313), "The cell of the atrio-ventricular bundle is short and very stout, the cells of the Purkinje fibers are longer and less stout, that of the myocardium is still longer and relatively slender. Moreover, each type multiplies its nuclei by amitotic division. The atrio-ventricular bundle cell more generally has only two nuclei; and an occasional nucleus may be seen in amitotic division. . . . The Purkinje fibers progress to a somewhat later stage characterized by an elongated fusiform shape, amitotic division of nucleus, and a fusion to form fibers, the fusion involving the formation of discs."

4. Delimitation of Purkinje Cells of Adult Type

The delimitation is brought about by structures very variously named. Among the terms used we may note intercalated discs, cement lines, intersegmental or intercellular septa, junctional lines, step-like lines. We have already seen that cells of embryonic type are generally isolated laterally by an endomysial membrane and are placed end to end although separated from each other by an intercalated disc. This disc is always traversed by myofibrils continuous from one cell into the other. Precisely the same arrangement is found in the case of the elements of adult type which are much longer than broad. Figs. 16, 17, 19 and 31 show this endomysium (enm) and the junctional lines (id). Even in Fig. 40 reproduced at a magnification of 103 diameters one can see a precise delimitation of all the elements which are oriented

in very different directions. On account of this precise delimitation the Purkinje fibers, formed by the juxtaposition of cells, resemble fibers of the myocardium in which, however, the vascular interstitial connective tissue is much more abundant. If at first sight the lateral contours of the Purkinje fibers are less distinct, it is because the interstitial tissue between them is more reduced and many cells are found in stages of longitudinal cleavage.

From the point of view of structure the intercalated discs, examined in sections parallel with the axis of the fibers, generally appear as transverse lines staining deeply in coloring reagents. The disc appears striated (id, Fig. 31) each stria corresponding to a thickening or more deeply colored disc of a myofibril which, according to the majority of authors, is continuous across the junctional line. Not infrequently one sees double intercalated discs formed from two parallel bands united by finer fibers to form species of intercellular bridges.

Figures of this type clearly prove that the discs are formed essentially by segments of myofibrils more or less modified in their structure and chemical composition, as observed in heart fibers by Browicz (1893), Przewoski (1893), MacCallum (1897), Hoche (1897), Hoyer (1901) and others. If, however, the step-like formations are formed as M. Heidenhain (1902, 1911) affirms "aus parallel gestellten bacillenähnlichen Stäbchen," and "the simplest discs consist of rows of bacillary modified foci on adjacent fibrils" as recently stated by Jordan and Banks (1917, p. 317), then sections tangential to the discs should show the isolated rods cut transversely. Few authors analyse figures of this type. Jordan and Banks, although giving many such figures (their Figs. 7, 8 and 25), nowhere indicate these rods in cross-section. So far as these authors are concerned the discs are more or less homogeneous.

In our preparations sections tangential or oblique to the junctional lines of the Purkinje fibers and the fibers of the myocardium present identical figures. At first the junctional lines, as stated by Jordan and Banks and by other authors, affect only a part of the depth of the fibers. Moreover, they are represented by a network of anastomosed trabeculæ which are relatively thick and readily stainable in red with safranin or fuchsin (more so than the myofibrils). In the narrow spaces of this network is a clear liquid (id, Figs. 7, 13, 17 and 19). This coarse reticulum shows that the myofibrils, at the level of the intercalated discs, have undergone not only modification in structure and in chemical composition but also a special modification in arrangement. Instead of being united into small columns they are condensed and

packed into a system of ramifying and anastomosing bands which represent a meshwork in the spaces of which there exists a clear fluid. It is possible that this fluid corresponds to sarcoplasm or perhaps to a different substance colored black with silver nitrate and comparable to the intercellular substance found in an epithelium. Although as regards the syncytial nature of the myocardium and the atrio-ventricular bundle this problem is fundamental, we are unable to solve it. If at the level of the intercalated discs there exists no trace of intercellular cement, it is apparent that the entire system of cardiac fibers should be considered as a syncytial mass.

We ought also to draw attention to a second type of intercalated discs which are present to the number of two, three or more throughout the length of an elongated Purkinje cell between the two extremities of the cytoplasmic body and even at the level of the nuclear zone. These are accessory intracytoplasmic discs often disposed in terraced arrangement at different levels. They bear no relation to the cell limits and correspond to contraction zones. Many authors interpret in this way all the ladder formations found in the length of cardiac fibers. Among these are v. Ebner (1902), Hoffmann (1909), Arnold (1909), Aimé (1911), Jordan and Steele (1912). In their conclusions Jordan and Banks make the following statement (p. 327): "The new data disclosed in this investigation, namely, the origin of the intercalated discs in relation to surfaces of fusion of previously distinct myocardial elements, need not be prejudiced by a forced association with the hypothesis that the discs are essentially irreversible contraction bands."

Finally, we must remark that sometimes there can be seen an intercalated disc (id, Fig. 19) which subdivides transversely into two, one daughter-cell incompletely separated from its twin (pm). If the disc corresponds to a real intercellular delimitation, figures of this type would prove that a mother-cell can undergo not only a longitudinal cleavage into two daughter-cells, but also that these in their turn can undergo a transverse segmentation into two shorter and probably uninuclear elements.

5. Stages of Transition Between Purkinje Cells and Cardiac Cells (Transitional Cells)

The majority of authors state that the subendocardial plexus of Purkinje fibers may extend into the myocardium, at the same time changing its histological characters. Its branches become gradually thin and finally are reduced to a fiber consisting of a single chain of

cells which elongate and of which the myofibrils increase in number while at the same time the sarcoplasm diminishes in quantity. These transitional cells are followed by true cardiac elements. The transition may occur gradually, although sometimes it takes place abruptly. At other times Purkinje cells may reappear and be intercalated in a transitional zone or even in the first segment of the myocardial fiber. Many authors describe transitional cells of this type: v. Hessling (1854), Koelliker (1854), Aeby (1863), Romiti, Duval (1897), Minervi (1899), Hoyer (1901), Marceau (1902), Hofmann (1902), Tawara, Mönckeberg and the majority of more recent authors.

These transitional cells are represented in Fig. 42. There one can see a Purkinje cell of adult type containing one nucleus at each of its poles (np^{I}, np^{II}) and other elements which have undergone structural changes more and more marked from the right to the left. The myofibrils increase in number, the sarcoplasm becomes less abundant and the transverse striation more marked (pc). The cells become more deeply stained and much resemble the cardiac elements in Fig. 7, but their longitudinal striation remains as pronounced as the transverse. They are transitional stages such as are equally visible (pc) in Figs. 10 and 11, and prove that in the normal human adult Purkinje fibers can develop in such a manner as to become transformed into cardiac cells (cf, Fig. 13). This conclusion is based upon the following three other facts:

1. The great number of myocardial fibers which are found scattered among the Purkinje fibers and recognizable even at a low magnification (cc, Fig. 40). For the most part these elements undoubtedly owe their origin to a transformation of Purkinje cells.

2. The great number of cardiac cells produced, especially in the pathological heart, from the longitudinal asymmetrical cleavage of a mother-cell into two or three daughter elements (asp^{III}, Figs. 22, 23 and 29; $asp^{II}a$, $asp^{III}a$, Fig. 32). Many of these daughter-cells just parting from their twin or already completely separated therefrom show in transverse sections a deeply stained appearance characteristic of the cytoplasm of cardiac cells (cf). The myocardial cell (cc) in Fig. 23 has resulted from an axial differentiation in a Purkinje mother-cell (pm).

3. The existence of plexuses or very complicated muscular meshworks the majority of the trabeculæ of which are formed by cardiac fibers (cf, Fig. 41), by a few occasional Purkinje cells (p) and by

transitional elements (pc). The majority of the cardiac fibers should be considered as originating from the Purkinje fibers.

The origination of transitional cells and their transformation into cardiac elements prove that the Purkinje cell, although of a special structure related to the particular functions which it fulfills, can acquire in the course of its evolution a morphology identical with that of the myocardial elements. Its sarcoplasm always remains capable of becoming differentiated and producing new myofibrils. When the contractility of the heart demands new cardiac fibers, these are furnished by the Purkinje cells which until then functionate in the transmission of the wave of contraction and are constructed accordingly. When the anatomical basis necessary for this transmission is definitely established to the point at which conduction is certain, some Purkinje elements seem to become useless and are capable of being transformed into constituent myocardial parts.

We are in accord with Marceau when he states: " Bien que provenant d'éléments identiques, les cellules cardiaques embryonnaires, ces deux formations (cellules de Purkinje et cellules cardiaques) se différencient l'une de l'autre de très bonne heure et dès lors se développent parallèlement en se rapprochant chacune progressivement d'un type défini " (p. 60). But we must add that in the normal man of 36 years certain Purkinje cells, which have become useless from the point of view of the functions which they should fulfill, develop further and become transformed into cardiac elements. In the pathological heart of a man of 42 years a much greater number of Purkinje cells are undergoing a similar transformation to such a point that it appears to us really pathological. Part of the cardiac trouble in heart-block may be set down to a pathological evolution of these constituent parts of the atrioventricular bundle. One may inquire if alterations of this type do not constitute the principal factor causing more or less transient interferences with cardiac rhythm in persons apparently normal.

6. The Sarcolemma of the Purkinje Cells

We have already stated that Schockaert described around all the Purkinje fibers of the sheep's heart a membrane stained blue with iron hæmatoxylin. It separates the elements one from the other and also from the neighboring connective tissue. Jordan and Banks describe and figure around the cells of the " moderator band " of the beef a sarcolemma generally festooned and state that " the telephragmata are

in intimate union with both the sarcolemma and serrations of the nuclear membrane" (p. 302). Speaking of the "atrio-ventricular connective bundle" they find that "the serrations in the enveloping sarcolemma are fixation artefacts" (p. 304). Round the Purkinje cells in process of fusion to form a Purkinje fiber, Jordan and Banks describe various short discs all along the surfaces of fusion and state that "the connecting membrane represents the fused sarcolemmata of the adjacent fibers" [cells] (p. 308).

We have previously seen that the lateral delimitation of the Purkinje cells of embryonic type and of those of adult type also is brought about by an endomysial membrane of connective-tissue-like structure stained blue by Mallory's method and green with light-green. The transitional cells are separated laterally by a similar membrane (sa, Fig. 42). At all these stages in the evolution of the Purkinje cell there can be found in obliquely longitudinal sections simple endomysial septa connected to the discs Z of neighboring myofibrils in such a manner as to give the appearance of a kind of festooned membrane (sa, Fig. 42). Fig. 9 (enm) shows a similar arrangement in the cells of embryonic type and Fig. 16 (enm to the left) in cells of adult type. If transverse sections of the atrio-ventricular bundle of the normal heart (Figs. 21 and 22) be attentively examined, there is clearly seen in several places a deeply staining membrane surrounding the Purkinje cell and often distinct from the neighboring interstitial connective tissue. It is continuous with the cleavage septum between the daughter-cells (pt^{II}, Fig. 22). In the pathological heart this membrane is even more distinct (asp^{III} and asp^{II}, Fig. 23). It may attain a considerable degree of thickness and constitute a thick sheath continuous between the two daughter-cells (p^{II}, Fig. 24; pc, Fig. 23). Such formations undoubtedly present the greatest similarity to the sarcolemmata described by various authors around the cardiac cells. Reference may be made in this connection to the following authors: Cajal (1888), Oestrich (1894), Hoche (1897), v. Ebner (1902), Heidenhain (1901, 1911), Renaut and Mollard (1905), Irene von Palczewska (1910) and Marie Werner (1910). This membrane is visible in our Fig. 7 (enm) surrounding the cardiac fibers. We shall not discuss at all the connective or cytoplasmic origin of this sarcolemma festooned around the myocardial cells. We shall content ourselves with stating that the Purkinje cells possess no trace of a true cellular membrane formed by their cytoplasm, but that they are circumscribed laterally by a membrane-like connective

system of endomysium which often figures as a false festooned sarcolemma. The marked hypertrophy of these membranes and their consequent sclerosis round many Purkinje cells in the pathological heart (pc, Fig. 23) constitutes another indubitable proof of their connective-tissue nature.

7. Arrangement of the Purkinje Fibers in the Atrio-Ventricular Bundle

This arrangement should be studied in longitudinal sections parallel with the axis of the bundle and in transverse sections of the bundle.

a. longitudinal sections

In longitudinal sections it is readily seen that the Purkinje cells of both atrial and ventricular segments are arranged end to end to produce fibers. These are more or less parallel with each other and with the axis of the bundle. They are bound together by short obliquely placed branches so that in reality they form a network, the parallel limbs of which are much longer than the oblique anastomotic ones. These fibers are only one cell thick and the cell in the normal heart is of greater diameter than a cardiac element. The longitudinal branches of this network may attain the length of myocardial fibers. The spaces of the network are very narrow (Figs. 17, 19, 20, 31 and 42) and occupied by a very small quantity of vascular connective-tissue (endomysium). The spaces are much larger in the myocardium (Fig. 7), but in the pathological heart the interstitial tissue may be hypertrophied and bring about considerable increase in the size of the Purkinje network spaces.

This arrangement of fibers as parallel bands comparable to that of the cardiac fibers does not exist throughout. In various places Purkinje cells tend to group themselves in a particular manner.

1. The short cells of embryonic type arrange themselves end to end to form thick Purkinje fibers resulting in an irregular network with very short trabeculæ and very narrow meshes occupied by an endomysium delimiting the lateral surfaces of the cells (Figs. 1 and 2). Often these cells possess intercrossing (Figs. 3, 4 and 8) or plexiform myofibrils (Figs. 11 and 13).

2. Similar networks may present a more complicated arrangement in that the short cells are distributed radially around a central node.

Such are the cellular plexuses of Purkinje (Fig. 12) or the stellate plexiform formations (Fig. 14).

3. The intercalated or association-cells, generally short and thick, bind the longitudinal muscular bundles to the axis of which these cells are placed obliquely or at right angles. The intercalated cells may assume an arrangement in which the individual elements are more or less parallel with each other (Fig. 10) or bound together in network formation (Figs. 11 and 13).

4. At the right atrio-ventricular junction (Piece 5) in the normal heart and also in that of the pathological organ we have noted a whorl-like arrangement of the fibers. In a section parallel with the bundle at this level many groups of Purkinje fibers can be seen (Fig. 40) of which six are well defined (gr^{I-VI}). The razor has cut the majority of these groups more or less longitudinally, but the bundles or the groups of fibers are oriented each in a different direction to form a whorl. We have noted a spiral arrangement less marked in the left ventricular branch (Piecé 8) of the normal heart and in the right ventricular branch (Piece 3) of the pathological organ.

B. TRANSVERSE SECTIONS

In transverse sections one notes immediately at certain levels in the atrio-ventricular bundle that the Purkinje fibers are grouped into fascicles of varying thickness. These are separated by relatively thick connective-tissue septa of the perimysium (pem, Fig. 26) which penetrate into the interior of the bundle where they become continuous with the thinner endomysial septa (enm).

This arrangement in bundles is even better marked in other segments of the normal atrio-ventricular bundle. It is visible in the ventricular segments (Figs. 21, 49 and 50), at the right atrio-ventricular junction (Piece 5; Fig. 40), in the septal wall of the right atrium (Piece 7; Figs. 22 and 43) and in other atrial segments (Figs. 47 and 48). But it may become more accentuated in different parts of the pathological heart because of the hypertrophy of the interfascicular connective-tissue. Our studies show this to be the case in the ventricular segments (Figs. 23, 27, 29 and 45, and especially in Figs. 28, 30, 32, 34 and 46), at the right atrio-ventricular junction (Piece 5; Fig. 44) and in the atrium (Fig. 51).

At certain places where the atrophy of the Purkinje fibers is very pronounced the endomysium may become so thick that the fascicular

arrangement is more or less effaced (Figs. 28, 29 and 32). But in this case there are still generally recognizable groups of two, three or four daughter-cells produced by the longitudinal cleavage of one or two mother-cells. The hypertrophied interfascicular and intrafascicular connective-tissue is sometimes dense and compact, being sclerosed throughout its entire extent (Figs. 28 and 30). In other cases it has more of an areolar appearance and is vascular (Figs. 23 and 29) in which case the pericellular sheath is formed by a denser sclerosed tissue (Figs. 23 and 29).

The fascicular arrangement of the Purkinje fibers is not constant. Quite often there are to be seen areas of normal and pathological atrio-ventricular bundles in which the interfascicular tissue is scarcely thicker than the intrafascicular tissue and in such cases the fibers appear to be more or less equidistant from each other.

The majority of authors agree regarding the existence of a connective-tissue sheath with numerous elastic fibers surrounding several segments of the atrio-ventricular bundle. Among others may be cited v. Hessling (1854), Reichert (1854), Ranvier (1876), Durand (1879), Renaut (1893), Marceau (1902), Tawara (1906), Fahr (1907), De Witt (1909), Lhamon (1912) and King (1916). While some, like Ranvier, Durand and Renaut, claim that the connective-tissue never penetrates between the constituent cells of a trabecula of Purkinje, others insist that it is prolonged between these elements. In the terminal arborizations of the atrio-ventricular bundle of the sheep, Tawara describes, round each strand many cells thick, a fine connective-tissue sheath " die wohl hier und da Septen in das Bündel hineinsendet und förmliche Einkerbungen und Einschnürungen der Oberfläche bedingt, aber nirgends das ganze Bündel in einzelne Fasern zerlegt" (p. 127). According to Fahr the atrio-ventricular bundle in the human embryo contains a more abundant connective tissue than the cardiac muscle. Because of this it is possible to distinguish it from the myocardium. Mall (1912) recognized it in two embryos of 50 mm. length by the appearance of its cells which " are more epithelial " and states that in one of the two " this differentiated band can be followed into both of its divisions, one of which reaches to the moderator band." Further on this author adds, " It is thus seen that the atrio-ventricular bundle is present in an embryo 8 mm. long and that as soon as the muscle of the rest of the atrial canal is broken down it becomes outlined by encircling spaces which are now formed."

In describing the structure in man of the inferior part of the left ventricular branch in which Purkinje fibers exist, Mönckeberg claims that each fiber is surrounded by a delicate connective-tissue sheath which "stellenweise eigenartige septenförmige Fortsätze in die Fasern selbst hineinsendet." But this author in no way recognizes the importance or the significance of these prolongations.

B. ENDOCARDIUM[1]

1. THICKNESS

It is known that the endocardium is much thicker in the atria than in the ventricles. According to v. Ebner (quoted by Schäfer, p. 323) its transverse diameter in the right atrium is five times greater than in the left ventricle. We intend to draw attention to the thickness and to certain details of structure of this endocardium over different segments of the atrio-ventricular bundle. Its transverse diameter varies very greatly according to the area and to the pathological alterations undergone. Three types of endocardium may be distinguished, the first thin, the second of medium thickness and the third thick, but it is evident that all intermediate stages will be encountered.

In the normal heart a thin endocardium is illustrated in Fig. 26 (Piece 10) which represents a transverse section of the base of the left posterior papillary muscle. The endocardium is of a similar type in the moderator band of the right ventricle (Piece 1), at the base of the anterior papillary muscle itself (Piece 2), in the course of the right branch (Piece 3), over the stem (Piece 4) and close to the right atrio-ventricular junction (Piece 5). In the left ventricle the endocardium is thin near the base of the posterior papillary muscle (Piece 10) and at the level of the left posterior branch (Piece 9).

Figs. 49 and 50 (Piece 8) show an endocardium of medium thickness and represent transverse sections of the left posterior ventricular branch near its commencement. The endocardium is of almost the same diameter at the base of the left posterior papillary muscle (Piece 11) and in the neighborhood of the superior vena cava (Piece 15; en, Fig. 48).

The endocardium attains its greatest thickness in the right atrium on the septal wall (Piece 7; en, Fig. 43), in the neighborhood of the coronary opening (Piece 6) and at the right of the atrio-ventricular junction (Piece 5).

[1] See table in Summary, page 53.

From these observations it follows that in the heart of a normal man of 36 years the endocardium is thinner in the right ventricle than in the left, that in general it is very thin in both ventricles, although it may attain a medium thickness at the level of certain portions of the atrio-ventricular bundle in the left ventricle. In the right atrium it is much thicker than in either ventricle, but is only of medium thickness close to the orifice of the superior vena cava.

In the pathological heart the endocardium is markedly thickened in several regions but one must remark that the endocardium may show different appearances in the same section. As an example we may mention the endocardium which covers the stem of the bundle (Piece 4). This portion of the atrio-ventricular bundle is surrounded by a thick layer of dense connective tissue which is in direct continuity with the endocardium (Fig. 46) which consists of a superficial zone of a loose areolar tissue (en) and a thick subjacent zone (ens) of sclerosed tissue. It completely surrounds the bundle and separates it from the neighboring myocardium (lc). Not only does the endocardium attain an extreme thickness in this location but the bundle seems actually to lie within it. Now at a certain distance from the pars membranacea and on each side of the bundle there is to be observed a thin lamina of Purkinje fibers much greater in diameter than those of the bundle itself. This lamina is covered by thin endocardium directly continuous with the less dense of the two layers of endocardium already described in the foregoing part of this paragraph (en, Fig. 46). This structural feature proves that quite often in consequence of hypertrophy or of localized sclerosis the endocardium may increase markedly in thickness in certain sites whereas somewhat lateral to the sclerosed area it becomes suddenly or gradually thinner.

In the pathological heart a thin endocardium occurs in the right ventricle at the surface of the anterior papillary muscle (Piece 2) and in certain locations over the main stem (Piece 4), in the right atrium in certain areas of the septal wall (Piece 7) and close to the orifice of the superior vena cava (Piece 15).

Endocardium of medium thickness in the pathological heart occurs in the right ventricle in the moderator band (Piece 1) and at the surface of the proximal part of the right branch (Piece 3); in the left ventricle over the proximal part of the left posterior branch (Piece 8; en, Fig. 35), over its distal portion (Piece 9; en, Fig. 27) and at the base of the posterior papillary muscle (Piece 10); in the right atrium

upon the septal wall (Piece 7) and certain areas adjoining the orifice of the coronary sinus (Piece 6).

The endocardium attains its greatest thickness in the pathological heart in the atrium on the septum between the coronary orifice and the fossa ovalis (Piece 14; en, Fig. 51; Piece 6) and near the orifice of the superior vena cava (Piece 16). Similarly, it is very thick at the base of the posterior papillary muscle of the left ventricle and over the main stem at the origin of the right ventricular branch (Piece 4; en, Fig. 46).

From the foregoing we note the following facts:

1. In general the endocardium is thinner in the right ventricle than in the left, but it is much thicker in both ventricles of the pathological heart than in those of the normal organ. It therefore participates in the chronic inflammatory process provoked by syphilis.

2. In general the endocardium is thicker in the right atrium than in the ventricles. The difference is not so obvious as in the normal heart, however, because it has not undergone marked hypertrophy or sclerosis as in the case of the ventricles.

We do not intend to make a study of the structure of the endocardium in the human heart. This has been done by several authors. We shall simply refer to the description given by Gustave Mann in Schäfer's Textbook of Histology, 1912, Vol. 2, p. 321, and for the description of layers of smooth muscular fibers and elastic fibers to the works of Nagayo (1909) and of Alexander Gibson (1909).

2. ELASTIC FIBERS

Elastic fibers are very abundant in the endocardium and in certain locations they form two or three networks which tend to result in fenestrated membranes the fibers of which are of very variable diameter. Fig. 52 is from a section obliquely tangential to the surface of the endocardium of the septal wall of the right atrium (Piece 7) in the normal heart. In it may be observed the following features:

1. The superficial endothelial membrane with visible nuclei (nen).

2. Under this there is a thin pale zone, the subendothelial layer formed by bundles of very fine collagenous fibrils.

3. A first elastic membrane (em^{I}) of very delicate fibers ramifying and anastomosing to form a network with narrow meshes resulting in a real fenestrated membrane in certain areas.

4. A second elastic membrane of fibers of medium thickness (em^{II}) underlying the preceding. The spaces of this reticulum are larger,

although in certain areas they become narrowed and the network acquires the characters of a fenestrated membrane.

5. A third elastic network, the deepest of all, of very thick fibers (em^{III}) and large interstices. In some places the meshes become reduced owing to an increase in diameter of the fibers and especially to an enlargement of the nodes of the reticulum. In this layer there likewise appear areas resembling a fenestrated membrane with meshes of variable size.

The first elastic membrane is most clearly seen in Fig. 53 (em^{I}) in the endocardium of medium thickness covering the left posterior branch (Piece 9) of the atrio-ventricular bundle in the pathological heart. The fenestrated membrane appearance in it is very distinct. Fig. 54, a photograph of the same segment (Piece 9 of the pathological heart) shows more clearly the fibrous expansions at the level of the nodes and the appearance of what seems to be a fenestrated membrane close beside other areas with very large interstices.

The three elastic membranes in Fig. 52 are separated by narrow intervals in which the elastic fibers are less numerous and the collagenous fibrillar bundles more abundant. In these two photographs of the pathological heart are visible near the connective-tissue cells (nc, Fig. 54) certain white globules, leucocytes (le, Figs. 53 and 54) and even white globules with polymorph nuclei (lpo, Fig. 53).

It is clear that one cannot find the three elastic membranes in all the different segments of the endocardium especially in the thin areas, but even in these there is a very considerable quantity of elastic filaments. The three figures just mentioned show also that the increase in thickness of the endocardium in the pathological heart is not due solely to the slow formation of a collagenous tissue, but equally to the production of new elastic elements. In certain areas of the hypertrophied endocardium these are as numerous as in the normal tissue.

3. SMOOTH MUSCULAR FIBERS

The inflammatory process appears to have a more detrimental influence upon the smooth muscular fibers. First we must remark that the brief statements made in the tabular summary present only a relative value. In speaking of the existence of a more or less continuous layer of smooth fibers or of two layers in an atrio-ventricular segment we have intended to imply that in certain places or throughout a considerable extent of the segment our preparations show the specified

details of structure. It is to be understood that the smooth fibers never form a tunica media so thick or so continuous as they do in the large arteries.

Reviewing the tabular summary and comparing the different statements there made we are led to the following conclusions:

NORMAL HEART

1. Smooth muscular fibers exist throughout almost the whole extent of the endocardium which covers the various ventricular segments of the atrio-ventricular bundle except the portion related to the right ventricular branch as it lies on the septal wall (Piece 3). Most frequently they occur as isolated scattered fibers near the middle of the thickness of the endocardium, sometimes (Pieces 2 and 8) as cells bound into bundles (scb, Fig. 50) or as bundles united into a more or less continuous layer (Pieces 4 and 8) as in Fig. 49 (lsc). They are a little more numerous in the left ventricle than in the right.

2. The smooth muscle fibers are undoubtedly much more numerous in the right atrium than in the ventricles. Relatively infrequent on the septal wall proper (Piece 7) they form a more or less continuous layer (Piece 6) and even two distinct continuous layers (lsc, Fig. 48) where the atrial branches border upon the orifice of the coronary sinus and of the superior vena cava (Piece 15).

PATHOLOGICAL HEART

1. No smooth muscular fibers are visible at all in the right ventricle or along the stem of the bundle. In the left ventricle they are lacking over the left posterior branch (Piece 9); but there do exist scattered bundles in the three other blocks of tissue from this ventricle (Pieces 8, 10 and 11). In the right atrium there are some isolated fibers or bundles near the opening of the coronary sinus (Pieces 6 and 14) and of the superior vena cava (Piece 15). They are not present upon the septal wall (Piece 7).

2. Smooth muscle fibers are, then, more numerous in the left ventricle than in the right, precisely as we found in the normal heart, but they are undoubtedly much more numerous in the ventricles of the latter than in those of the pathological organ.

3. In the syphilitic heart the smooth muscle fibers are scarcely more numerous in the right atrium than in the left ventricle.

4. As a result of the pathological process the smooth muscle fibers are much rarer in the syphilitic heart than in the normal specimen. We do not know at what age smooth muscle fibers appear in the endocardium and we do not know the precise date at which the patient contracted the syphilis which arrested the development of smooth muscle. We are therefore unable to discuss the question whether or no this tissue had attained its complete development in the syphilitic patient. It appears to us indisputable, however, that the sclerotic process has exercised a marked influence towards atrophy and disappearance of the smooth muscle cells of the endocardium.

In this connection it is interesting to note the sclerosis and atrophy of the tunica media both of the larger arteries and of the smaller arterial branches in the atrio-ventricular bundle. The coronary artery and the two other arterial branches visible in Fig. 44 (as), from Piece 5, possess walls from which the media has completely disappeared, since it has been transformed into a dense connective tissue. In the whole series of sections one cannot find a single normal smooth muscle fiber. In the same figure one sees, however, other small arterial branches which are normal (ar, arc). In the wall of the large artery which runs in the atrio-ventricular bundle (Piece 4) one encounters here and there a normal smooth muscle fiber, but the greatest part of the media is sclerosed (as, Fig. 46), whereas other much smaller branches are unaltered (ar). In the thick bundle of Purkinje fibers from the left posterior papillary muscle (Fig. 45 from Piece 11), a short distance from the vein (v) there is to be seen a completely sclerosed arterial branch (as). Arteries of a considerable size, the seat of a more or less advanced sclerosis of the smooth muscle fibers, are present in the majority of the atrial and ventricular segments of the atrio-ventricular bundle. These lesions must entail profound alterations in the muscular cells to which they carry blood.

We are then forced to the conclusion that the syphilitic process has exercised a detrimental influence upon the muscular fibers of many arteries of the atrio-ventricular bundle and upon those of the neighboring endocardium.

Smooth muscular fibers are rarely met with under the endocardium in the normal heart and even under the layer of Purkinje fibers. In Fig. 50 (Piece 8) may be observed between the thin layers of Purkinje fibers (lp) and the myocardium (lc) two bundles of smooth muscle fibers cut transversely (scb), the one large and the other smaller.

At a suitable magnification these elements show all the characters of smooth muscle cells. There is also another group of them situated likewise between the myocardium and the Purkinje layer in the same Piece 8 of the pathological heart.

The course of the smooth muscle fibers in the endocardium is generally more or less parallel with the axis of the atrio-ventricular bundle, for transverse sections of the bundle cut them transversely (lsc, Fig. 49). But in sections tangential to the internal surface of the endocardium isolated smooth muscle fibers show a tendency to form a network (sc, Figs. 56, 57 and 58), while the muscular bundles decussate in different directions (scb, Fig. 55) presenting a whorled arrangement recalling that already described in the case of the bundles of Purkinje fibers (Fig. 40).

In the meshwork of isolated smooth muscle fibers one can note triangular elements of exceptional form (sct, Fig. 56). The nucleus itself generally rod-like (sc, Fig. 56) may assume a triangular form (sct, Fig. 56). Figs. 57 and 58 show us two examples of two smooth fibers anastomosed end to end (sca). In Fig. 58 one of the two elements (sc) united by a fine anastomotic branch is not exactly in focus, but from the preparation one can state positively that the segment sca is certainly continuous with the two cells in question. Examples of anastomosed smooth fibers were described for the first time by Flemming in the bladder of Batrachia.

C. TRACES OF INTERSTITIAL INFLAMMATION IN THE PATHOLOGICAL HEART ALONG THE ATRIO-VENTRICULAR BUNDLE AND IN THE SUPERFICIAL ENDOCARDIUM

The tabular summary shows that in many segments of the bundle there exist traces of an infiltration of lymphocytes and leucocytes, but nowhere does it encroach upon the neighboring myocardium. This slight and diffuse inflammation can be seen at a low magnification (cti) in Figs. 41 (Piece 5) and 45 (Piece 11) and at a greater magnification (cti) in Fig. 24 (Piece 10) and (le) Fig. 12 (Piece 1). It is manifested by the invasion of leucocytes into the connective tissue, the epi-, peri- and endo-mysium and even into the neighboring endocardium. But in certain areas, especially in the left ventricle (Pieces 9, 10 and 11), the infiltration, whether diffuse or localized to certain centers is much more accentuated. Fig. 27 (Piece 9) shows this at a low magnification in the endocardium (cti) and in the zone of Purkinje fibers (cti). It is very pronounced in the Purkinje zone of Fig. 36 (cti).

In Fig. 60 which represents a segment of the endocardium (Piece 9) reproduced at 535 diameters there are recognizable lymphocytes (ly) with a small nucleus rich in chromatin, leucoblasts (le) bulkier with a simple nucleus surrounded by a more abundant protoplasm, and polymorphocytes with a lobed nucleus (lpo). Sometimes one sees even red corpuscles extravasated in quite considerable numbers (rc). Among these cells others are found known as "mast-cells," the protoplasm of which is packed with large granules staining with safranin, but one must remark that this last variety is present to as great an extent in the normal heart as in the pathological specimen.

In examining closely series of preparations in which the endomysium and the perimysium of the atrio-ventricular bundle are invaded by a considerable number of leucocytes we have been surprised to observe that the Purkinje cells generally resist this invasion and remain intact. There are, however, some exceptions as exemplified in Fig. 61. The cell p encloses in a large clear sarcoplasmic zone a mass of leucocytes (le) and two others exhibit leucocytes in their cortical myofibrillar zone (le) while the mother-cell (pm) adjoining is entirely free. Fig. 62 shows a second example of leucocytes enclosed in the sarcoplasm of a Purkinje cell where they undergo a kind of disintegration and karyolysis. This figure seems to show that the Purkinje element is endowed with phagocytic properties which permit it to destroy and to digest the invading cells.

The inflammation, although generally slight and particularly little marked in the right atrium, sufficiently explains the chronic hypertrophy undergone by the interstitial tissue and the endocardium in certain ventricular segments.

We shall dwell scarcely at all upon the fatty degeneration of the Purkinje fibers. Preparations fixed with osmic reagents show in the majority of segments of the atrio-ventricular bundle numerous groups of Purkinje fibers, the sarcoplasmic and cortical zones of which are packed with black, fatty granulations soluble in turpentine. But we must also note that the normal heart shows identical alterations induced by the pneumococcic infection. Fatty degeneration does not represent an alteration peculiar to heart-block, and Bullard (1916) has just demonstrated that "neutral fat is of normal occurrence in the muscle fibers of the bundle of His."

D. ENIGMATIC ELEMENTS

Before concluding this work we must draw attention to the occurrence of two enigmatic elements found, one in the pathological heart and the other in the normal organ. The first is represented in Figs. 59 and 65 (pel) representing, respectively, a transverse and a longitudinal section of a cardiac cell close to the Purkinje zone. One encounters these enigmatic elements only in the neighborhood of the orifice of the superior vena cava (Piece 16) and nowhere else. In the middle of the cell body there is seen a cluster or a sort of spireme formed by an interlacement of convoluted and spiral filaments of variable thickness and easily stainable with iron hæmatoxylin. In normal tissues there are but two kinds of elements which resemble even vaguely those of the two figures in question. First there are the chromosomes or chromatic clusters of a nucleus in mitosis. In the present case, however, there can be no question of karyokinesis, for the nucleus is in a resting condition and is visible to one side of the cluster (nca, Fig. 59). Secondly, in ovarian ova in the stage of growth in the bat (Vesperugo noctula, one of us (O. V. d. S., 1905), has described as "pseudochromosomes" certain convoluted and spiral filaments all around the yolk body and presenting an appearance somewhat similar to those of Figs. 59 and 65. These pseudochromosomes are formed in reality by accumulations of mitochondria (O. V. d. S., 1904). In spite of the resemblance of the enigmatic clusters to these pseudochromosomes we cannot consider them as formations of the same nature: indeed they are localized exclusively to a small segment of the myocardium and are in no wise generally distributed. This observation causes us to believe that the cluster represents rather a parasitic element. When one considers the nature of the disease from which the patient was suffering one naturally thinks of treponemata. Professor W. G. MacCallum has kindly examined these preparations but he is unable to recognize treponemata in the cluster. We must therefore content ourselves with stating that this formation is an enigmatic cluster probably of parasitic nature.

A second type of elements found only in the normal heart is visible especially at the level of the left branch just as it enters the ventricle (Piece 8) and of its posterior subdivision (Piece 9) in the substance of the bundle itself. These elements occur in the interior of the Purkinje cells of adult type and are represented by Figs. 63 and 64 (e). They are elongated oval bodies sometimes slightly swollen towards the middle. They are stained deeply with safranin and their

structure is in great part homogeneous like that of the red corpuscles visible in a neighboring capillary (cprc, Fig. 63). They often contain one or more small vacuoles filled with a pale liquid. They occur scattered to the number of from two or three to ten along the axial sarcoplasm of the Purkinje cell. In Fig. 64 one can count eight. Examined at a low magnification they resemble crystalloid bodies described as occurring in the genital glands and other organs which, however, present a more regular form and are represented by finer rods. They may be parasites though we cannot definitely so state. In a few preparations fixed in Flemming's fluid we have succeeded in staining with safranin the axial cytoplasmic band described in the earlier part of this paper as occurring in the Purkinje cells (st, Figs. 5 and 23). This axial strand presents a homogeneous structure which recalls that of the enigmatic elements (e) of Figs. 63 and 64. It may be that this filament can undergo fragmentation into numerous elements comparable with these enigmatic bodies, but we have been unable to discover different stages of any such fragmentation and we therefore doubt its possibility. We must in consequence refrain from any further statement upon the matter.

VI. SUMMARY

1. In the atrio-ventricular bundle in the normal heart of a man of 36 years and in the pathological heart of a man of 42 years we distinguish three varieties of Purkinje cells.

a. Cells of embryonic type, polyhedral or with the long axis somewhat exceeding the diameter. These contain several nuclei which may be clustered together or may show a tendency to deviate along the cell axis and into the lateral parts of the cytoplasm. These nuclei are surrounded by a central or axial sarcoplasmic zone, exceedingly poor in myofibrils, around which there is a cortical layer containing more numerous myofibrils. In regard to the course of these it is possible to distinguish cells with parallel myofibrils, cells with intercrossing myofibrils and cells with plexiform myofibrils which decussate in various directions. The two last mentioned types of elements constitute an anatomical basis which is important from the point of view of transmission of the contraction wave in different directions. Two other formations also present a noteworthy arrangement from this point of view: the intercalated or association cells the axis of which is at right angles or obliquely placed to that of the longitudinal muscular

bundles which they unite, and the cellular plexuses (occasionally stellate in appearance) of Purkinje.

b. Cells of adult type much longer than the foregoing and of which many are particularly bulky. These contain many nuclei which tend to distribute themselves laterally and through the length of the cell body like the nuclei of the embryonic type of cell. From this tendency it results that the element originally with a single axis becomes bipartite or tripartite; it possesses two or three axial bands of sarcoplasm towards each extremity of which are to be observed one or two nuclei. The myofibrillar cortical layer invades the central granular sarcoplasm and produces myofibrillar partitions which separate the two or three sarcoplasmic segments and accentuate in this way the multipartite character of the Purkinje cell.

c. Purkinje cells of transitional type showing stages of transition between Purkinje elements and myocardial cells.

2. Whatever may be the degree of evolution of a Purkinje cell it can always be distinguished from a cardiac cell by the abundance of its sarcoplasm which separates its myofibrils or fibrillar columns. Hence cut longitudinally it presents a longitudinal striation more accentuated than the transverse, whereas in myocardial fibers the transverse striation is predominant, although an isolated myofibril from a Purkinje cell shows transverse striation identical with that of the myofibrils of the myocardium.

3. All the muscular cells of the atrio-ventricular bundle possess the fundamental feature just mentioned. In the atrial segments the myofibrils are generally more regularly distributed throughout the large mass of protoplasm, whereas in the ventricular areas they occupy a cortical zone more or less distinct from the axial sarcoplasmic layer. But cells of the first type are also to be found in the ventricles and representatives of the second type occur in the right atrium. For these reasons it appears to us logical to include all these cells under the heading Purkinje cells.

4. Bulky Purkinje cells are capable of undergoing a longitudinal division or cleavage into smaller daughter-elements by the extension of the neighboring endomysium through the cell body. In this manner a bipartite or tripartite mother-cell divides into two or more smaller elements, multinucleated and more or less symmetrical or else completely asymmetrical in size and structure. In the last mentioned case one of the daughter-cells may present the structure of a transitional element

or indeed of a cardiac element while the other retains the primitive features of the Purkinje cell.

5. Longitudinal cleavage of Purkinje cells is manifested in the normal heart, but in the syphilitic organ it is so marked that it must be considered pathological. Because of the hypertrophy of the interstitial connective-tissue the cleavage affects a much greater number of Purkinje cells and constitutes the most important factor in the atrophy and disappearance of many of these elements.

6. In the pathological heart the connective-tissue septum (endomysium) of cleavage can undergo a considerable thickening and invade the neighboring daughter-cells in its turn, subdividing them into smaller symmetrical or asymmetrical elements the diameter of which hardly surpasses that of a smooth muscle cell. These markedly atrophied cells still possess, when they have retained the features of Purkinje type, a myofibrillar cortical layer and an axial sarcoplasmic zone between which there often appears an internal cytoplasmic membrane.

7. The atrophied elements in their turn may undergo a cleavage into smaller fragments which may be nucleated or on the other hand devoid of nuclei. The latter type represents the last vestiges of the Purkinje cell before its disappearance or complete sclerosis.

8. The pathological cleavage of the Purkinje cell may be accompanied by an amitotic division of the nucleus induced by the extension of the endomysial septum and in certain cases blood capillaries seem to play a predominant rôle in the invasion by the endomysium.

9. The Purkinje cells of adult and of transitional type place themselves end to end to form Purkinje fibers parallel with the axis of the atrio-ventricular bundle and are bound together by short oblique branches. The short cells of embryonic type form a network the fibers or trabeculæ of which are much shorter and the meshes narrower. All these elements are delimited laterally by the interstitial connective tissue which fills the spaces of the network and at their extremities by intercalated discs across which the myofibrils pass continuously from one cell to another. These transverse discs present the same structure and the same significance as those of the cardiac fibers. They do not traverse the entire thickness of the Purkinje cell. They are formed by thick segments of myofibrils and by a special clear substance. When these discs are seen from the surface one can observe that the myofibrils are condensed into a system of thick bands anas-

tomosed to form a network in the spaces of which there exists a clear fluid. We cannot say whether this liquid represents a part of the sarcoplasm or an intercellular substance. The solution of this problem would permit us to determine the syncytial or cellular nature of heart fibers.

10. Purkinje cells present a special morphology in accordance with the special functions which they fulfill. They possess the power of evolving and of transforming themselves into cardiac elements even in the normal state but in the pathological condition this process of transformation may become so accentuated that it appears to us as possibly constituting an important factor in the production of derangements of cardiac rhythm.

11. Surrounding the Purkinje cells laterally there is a very thin endomysial membrane which is continuous with the cleavage partitions appearing in the division of a mother-cell. It often presents a plainly festooned appearance, the discs Z of the neighboring myofibrils being attached along its internal aspect. It should be considered as a production not of the peripheral cytoplasm of the muscular cell but of the neighboring endomysium. It corresponds then to a kind of false sarcolemma. In the pathological condition this sarcolemma may undergo a considerable hypertrophy and with the sclerosed interstitial connective-tissue it forms a second very important factor which in the process of cleavage may exercise a marked influence toward the atrophy of the Purkinje elements.

12. The arrangement of the Purkinje fibers in bundles separated by an interfascicular perimysium thicker than the intrafascicular endomysium is apparent in many areas of different segments of the atrioventricular bundle. At the level of the pars membranacea septi or right atrio-ventricular junction bundles or groups of fibers all more or less parallel with the axis of the main bundle present a special whorled disposition.

13. The endocardium which covers different segments of the atrioventricular bundle presents a variable thickness. In the normal heart it is notably thicker in the right atrium than in the ventricles and it is thicker in the left ventricle than in the right. In the syphilitic heart it has undergone a considerable hypertrophy in the ventricular areas especially in the left ventricle. It therefore participates in the sclerotic process which affects the atrio-ventricular bundle.

14. Elastic fibers are very abundant in this endocardium and in certain locations they produce three successive networks which tend to become transformed into fenestrated elastic membranes. The increase in diameter of the pathological endocardium is due not only to the formation of new collagenous bundles, but also to the production of numerous elastic elements.

15. The endocardium related to the different segments of the atrio-ventricular bundle may include isolated scattered smooth muscular fibers, isolated bundles or sometimes more or less continuous layers of smooth muscle fibers. In the normal heart they are much more numerous in the atrium than in the two ventricles and a little more numerous in the left ventricle than in the right. In the syphilitic heart they are markedly diminished in number in the two ventricles and even in the atrium. There seems to us no doubt that the sclerotic process has exercised a considerable influence toward their reduction in number.

The larger vessels of the arterial circle at the atrio-ventricular junction (Pieces 4 and 5) as well as several small arteries belonging to the atrial and ventricular segments present similar sclerotic lesions; their tunica media is partially or entirely transformed into a fibrous layer.

16. In the pathological heart there exist traces of a slight diffuse inflammation along the majority of the segments of the atrio-ventricular bundle and its superficial endocardium. At certain levels in the left ventricle are to be observed centers of much more marked infiltration.

17. Sclerotic lesions of the interstitial connective-tissue and of the small arterial branches, atrophy of the Purkinje fibers and diffuse inflammation are much more accentuated in the ventricles than in the atrium and particularly in the left ventricle (Pieces 9, 10 and 11).

VII. GENERAL ABBREVIATIONS

ac,	fat cells.
ap,	atrophied Purkinje cells.
ap^{II},	group of two atrophied Purkinje cells.
ar,	artery.
arc,	artery filled with red blood corpuscles.
as,	artery affected by sclerosis.
asp,	asymmetrical Purkinje cells.
asp^{II},	group of two asymmetrical Purkinje cells (daughter-cells).
asp^{III},	group of three asymmetrical Purkinje cells (daughter-cells).

asp^{II}a, two asymmetrical atrophied Purkinje cells (daughter-cells).
asp^{III}a, three asymmetrical atrophied Purkinje cells (daughter-cells)
cc, cardiac cells.
cc^{II}, two daughter-cells of the cardiac type.
cf, cardiac fibers.
con, continuity of myofibrils between two different muscle cells.
cp, capillary.
cpc, capillary filled with red blood corpuscles.
ct, connective tissue.
cti, infiltrated connective tissue.
cts, connective tissue affected by sclerosis.
df, Purkinje cell with intercrossing myofibrils.
e, enigmatic element.
em^{I}, inner elastic fenestrated membrane or elastic network.
em^{II}, middle elastic fenestrated membrane or elastic network.
em^{III}, outer elastic fenestrated membrane or elastic network.
en, endocardium.
enm, endomysium.
ens, endocardium affected by sclerosis.
fg, fat granules.
gr, bundle or group of Purkinje fibers.
gr^{I-VI}, six groups of Purkinje fibers in whorl.
id, intercalated disc.
im, internal cytoplasmic membrane.
lc, layer of cardiac fibers.
le, leucocyte.
lp, layer of Purkinje cells.
lpo, polymorphocyte.
lsc, layer of smooth muscle cells.
ly, lymphocyte.
m, mitochondria.
n, nucleus.
nc, nucleus of connective-tissue cell.
nca, nucleus of cardiac cell.
nen, nucleus of endothelial cell.
np, nucleus of Purkinje cell.
np^{I}, np^{II}, np^{III}, np^{IV}, np^{V}, various nuclei in one Purkinje cell.
npc, nucleus of transitional cell.
p, Purkinje cell.
p^{I}, first daughter Purkinje cell.
p^{II}, second daughter Purkinje cell or group of two daughter Purkinje cells.
p^{III}, group of three daughter Purkinje cells.

pc, cell in transition between Purkinje and cardiac type.
pc^{II}, two daughter-cells of transitional type.
pel, enigmatic cluster.
pem, perimysium.
pig, pigment granules.
pm, Purkinje mother-cell.
pl, Purkinje cell containing a plexus of myofibrils.
pt^{II}, Purkinje mother-cell divided into two parts.
pt^{III}, Purkinje mother-cell divided into three parts.
pt^{IV}, Purkinje mother-cell divided into four parts.
rbr, right branch of the atrio-ventricular bundle.
rc, red blood corpuscle.
sa, sarcolemma.
sc, smooth muscle cell.
sca, anastomosis of two smooth muscle cells.
scb, bundles of smooth muscle cells.
sct, triangular smooth muscle cells.
st, axial cytoplasmic strand in a Purkinje cell.
v, vein.
vrc, vein filled with red blood corpuscles.

VIII. EXPLANATION OF FIGURES[1]

PLATE 1

1. Section tangential to the surface of the endocardium covering the posterior papillary muscle of the left ventricle (Piece 11) of the normal heart. Hermann's fluid, Mallory's stain; magnification 476 diameters.

2. Section tangential to the surface of the endocardium covering the posterior papillary muscle of the left ventricle (Piece 11) of the normal heart. Hermann's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

3, 4. Sections tangential to the surface of the endocardium of the right atrio-ventricular junction (Piece 5) in the normal heart. Hermann's fluid, Mallory's stain; magnification 476 diameters.

5, 6. Sections tangential to the surface of the endocardium over the left posterior ventricular branch of the bundle (Piece 9) of the pathological heart. Hermann's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

7. Section tangential to the surface of the endocardium covering the posterior papillary muscle of the left ventricle (Piece 11) of the normal heart. Hermann's fluid, Mallory's stain; magnification 476 diameters.

PLATE 2

8. Section tangential to the surface of the endocardium of the moderator band in the right ventricle (Piece 1) of the normal heart. Bouin's fluid, Mallory's stain; magnification 476 diameters.

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[1] A reduction of one-eighth has been made in the figures.

9. Section tangential to the surface of the endocardium of the moderator band in the right ventricle (Piece 1) of the normal heart. Hermann's fluid, safranin, light green; magnification 476 diameters.

10, 11. Sections tangential to the surface of the endocardium of the moderator band in the right ventricle (Piece 1) of the normal heart. Bouin's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

12, 13. Sections tangential to the surface of the endocardium of the moderator band in the right ventricle (Piece 1) of the normal heart. Bouin's fluid, Mallory's stain; magnification 476 diameters.

PLATE 3

14. Section tangential to the surface of the endocardium of the moderator band in the right ventricle (Piece 1) of the normal heart. Bouin's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

15. Section tangential to the surface of the endocardium of the moderator band in the right ventricle (Piece 1) of the normal heart. Bouin's fluid, Mallory's stain; magnification 476 diameters.

16. Section tangential to the endocardium of the right atrio-ventricular junction (Piece 5) of the normal heart. Hermann's fluid, safranin, light green; magnification 476 diameters.

17, 18, 19. Sections tangential to the surface of the endocardium covering the left ventricular branch of the bundle immediately below the aortic cusp (Piece 8) in the normal heart. Flemming's liquid, safranin, light green; magnification 476 diameters.

PLATE 4

20. Section tangential to the surface of the endocardium over the left posterior ventricular branch of the bundle (Piece 9) of the pathological heart. Hermann's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

21. Transverse section of the left posterior ventricular branch in the trabecular tissue (Piece 10) in the normal heart. Hermann's fluid, safranin, light green; magnification 535 diameters.

22. Transverse section of the septal wall of the right atrium (Piece 7) of the normal heart. Hermann's fluid, safranin, light green; magnification 476 diameters.

23. Transverse section of the left posterior ventricular branch in the trabecular tissue (Piece 10) of the pathological heart. Hermann s fluid; Mallory's stain; magnification 476 diameters.

PLATE 5

24. Transverse section of the left posterior ventricular branch in the trabecular tissue (Piece 10) of the pathological heart. Hermann's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

25. Transverse section through the left posterior ventricular branch of the bundle in the septal wall (Piece 9) of the pathological heart. Hermann's fluid, Mallory's stain; magnification 535 diameters.

26. Transverse section of the left posterior ventricular branch in the trabecular tissue (Piece 10) of the normal heart. Hermann's fluid, safranin, light green; magnification 85 diameters.

27. Transverse section through the left posterior ventricular branch of the bundle in the septal wall (Piece 9) of the pathological heart. Hermann's fluid, safranin, light green; magnification 85 diameters.

PLATE 6

28, 29, 30. Transverse sections through the left posterior ventricular branch of the bundle in the septal wall (Piece 9) of the pathological heart. Hermann's fluid, Mallory's stain; magnification 535 diameters.

31. Section tangential to the surface of the endocardium of the moderator band in the right ventricle (Piece 1) of the normal heart. Bouin's fluid, Mallory's stain; magnification 476 diameters.

32. Transverse section of the stem of the bundle (Piece 4) of the pathological heart. Flemming's liquid, iron hæmatoxylin, Congo red; magnification 476 diameters.

33. Section tangential to the surface of the septal wall of the right atrium (Piece 7) of the pathological heart. Trichloracetic acid, Mallory's stain; magnification 476 diameters.

PLATE 7

34. Transverse section of the stem of the bundle (Piece 4) of the pathological heart. Flemming's liquid, iron hæmatoxylin, Congo red; magnification 476 diameters.

35. Transverse section of the left ventricular branch of the bundle immediately below the aortic cusp (Piece 8) of the pathological heart. Bouin's fluid, Mallory's stain; magnification 103 diameters.

36. Section tangential to the surface of the endocardium covering the left posterior ventricular branch of the bundle in the septal wall (Piece 9) of the pathological heart. Bouin's fluid, Mallory's stain; magnification 103 diameters.

37. Section tangential to the surface of the endocardium covering the left posterior ventricular branch of the bundle in the septal wall (Piece 9) of the pathological heart. Bouin's fluid, Mallory's stain; magnification 476 diameters.

38. Transverse section of the wall of the right atrium including the orifice of the coronary sinus (Piece 6) in the pathological heart. Flemming's liquid, safranin, light green; magnification 476 diameters.

39. Transverse section of the left ventricular branch of the bundle immediately below the aortic cusp (Piece 8) of the normal heart. Flemming's liquid, safranin, light green; magnification 476 diameters.

40. Section tangential to the surface of the endocardium of the right atrio-ventricular junction (Piece 5) of the normal heart. Hermann's fluid, safranin, light green; magnification 103 diameters.

PLATE 8

41. Longitudinal section of the bundle at the pars membranacea septi (Piece 5) of the pathological heart. Hermann's fluid, Mallory's stain; magnification 103 diameters.

42. Section tangential to the surface of the endocardium covering the left posterior ventricular branch in the trabecular tissue (Piece 10) of the normal heart. Hermann's fluid, Mallory's method; magnification 476 diameters.

43. Transverse section of the septal wall of the right atrium (Piece 7) in the normal heart. Hermann's fluid, safranin, light green; magnification 103 diameters.

44. Transverse section of the right atrio-ventricular junction (Piece 5) of the pathological heart. Trichloracetic acid, Mallory's stain; magnification 45 diameters.

PLATE 9

45. Transverse section of the base of the posterior papillary muscle of the left ventricle (Piece 11) in the pathological heart. Bouin's fluid, Mallory's stain; magnification 103 diameters.

46. Transverse section of the stem of the bundle (Piece 4) of the pathological heart. Flemming's liquid, Mallory's stain; magnification 103 diameters.

47. Transverse section of the crista terminalis at the orifice of the superior vena cava (Piece 15) of the normal heart. Flemming's liquid, Mallory's stain; magnification 476 diameters.

48. Transverse section of the crista terminalis at the orifice of the superior vena cava (Piece 15) of the normal heart. Flemming's liquid, Mallory's stain; magnification 103 diameters.

PLATE 10

49, 50. Transverse sections of the left ventricular branch of the bundle immediately below the aortic cusp (Piece 8) of the normal heart. Flemming's liquid, safranin, light green; magnification 103 diameters.

51. Transverse section of the interatrial septum between coronary orifice and fossa ovalis (Piece 14) of the pathological heart. Bouin's fluid, Mallory's stain; magnification 103 diameters.

52. Section tangential to the surface of the endocardium of the septal wall in the right atrium (Piece 7) of the normal heart. Hermann's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

53. Section tangential to the surface of the endocardium covering the left posterior ventricular branch of the bundle in the septal wall (Piece 9) of the pathological heart. Hermann's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

PLATE 11

54. Section tangential to the surface of the endocardium covering the left posterior ventricular branch of the bundle in the septal wall (Piece 9) of the pathological heart. Hermann's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

55. Section tangential to the surface of the endocardium covering the left ventricular branch of the bundle immediately below the aortic cusp (Piece 8) of the normal heart. Flemming's liquid, Mallory's stain; magnification 103 diameters.

56, 57, 58. Sections tangential to the surface of the endocardium covering the right atrio-ventricular junction (Piece 4) of the normal heart. Bouin's fluid, Mallory's stain; magnification 476 diameters.

59. Transverse section of the margin of the superior vena caval orifice (Piece 16) of the pathological heart. Bouin's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

PLATE 12

60. Transverse section of the endocardium covering the left posterior ventricular branch of the bundle in the septal wall (Piece 9) of the pathological heart. Hermann's fluid, Mallory's stain; magnification 535 diameters.

61. Transverse section of the left posterior ventricular branch of the bundle in the septal wall (Piece 9) of the pathological heart. Bouin's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

62. Transverse section of the left posterior ventricular branch of the bundle in the septal wall (Piece 9) of the pathological heart. Bouin's fluid, Mallory's stain; magnification 476 diameters.

63. Section tangential to the surface of the endocardium covering the left ventricular branch of the bundle immediately below the aortic cusp (Piece 8) of the normal heart. Flemming's liquid, Mallory's stain; magnification 476 diameters.

64. Section tangential to the surface of the endocardium covering the left ventricular branch of the bundle immediately below the aortic cusp (Piece 8) of the normal heart. Flemming's liquid, safranin, light green; magnification 476 diameters.

65. Transverse section of the margin of the superior vena cava orifice (Piece 16) of the pathological heart. Bouin's fluid, iron hæmatoxylin, Congo red; magnification 476 diameters.

PLATE 13

66. Heart 1 opened to show areas from which tissue blocks were removed for histological examination (see p. 4) of right side.

67. Heart 1 opened to show areas from which tissue blocks were removed for histological examination (see p. 5) of left ventricle.

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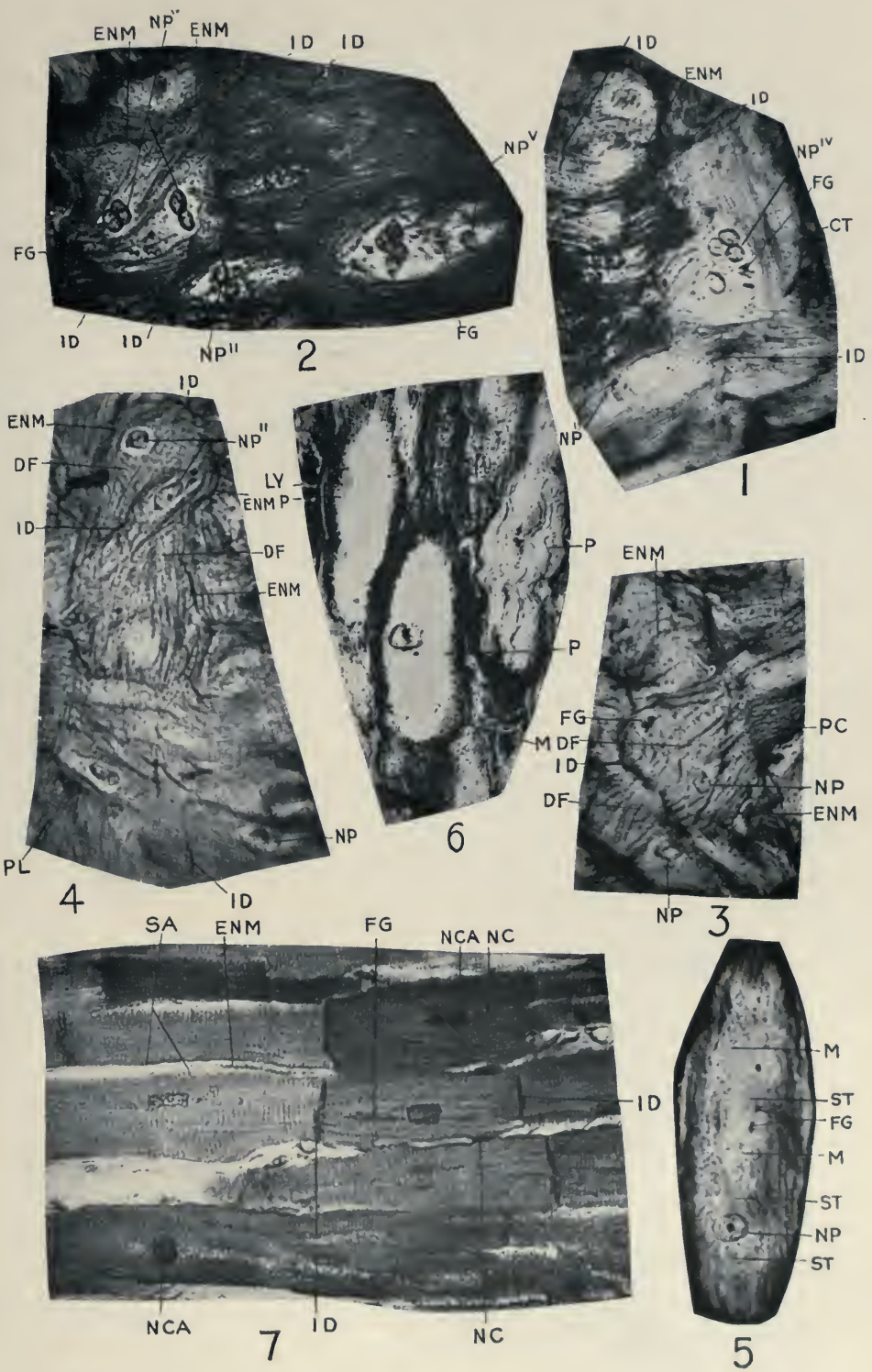
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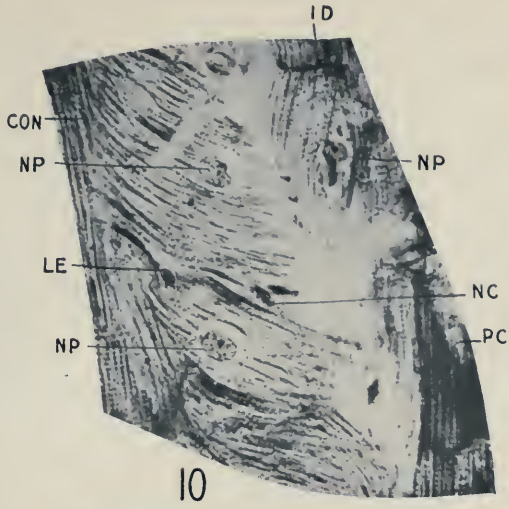
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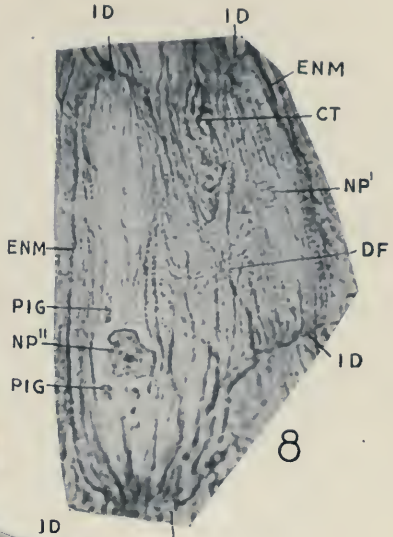
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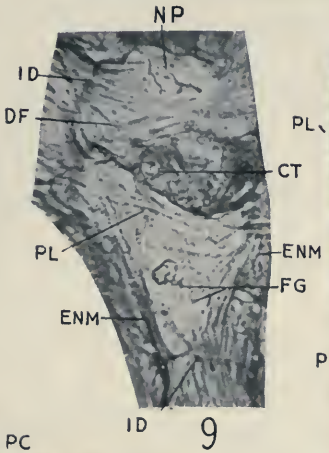
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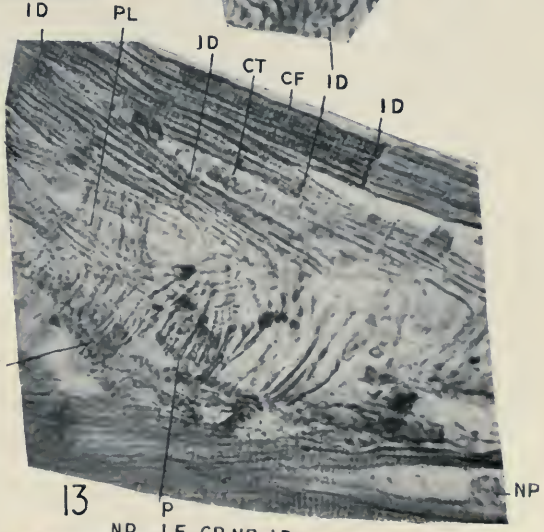
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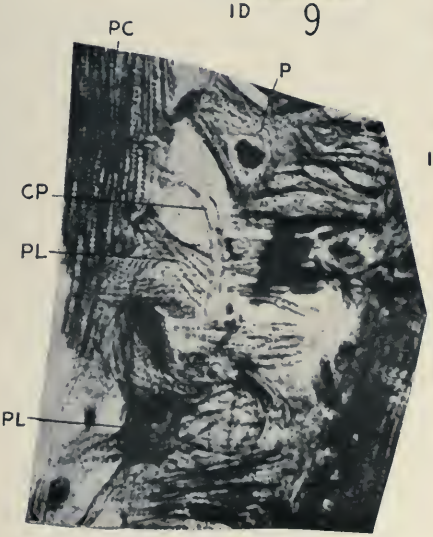
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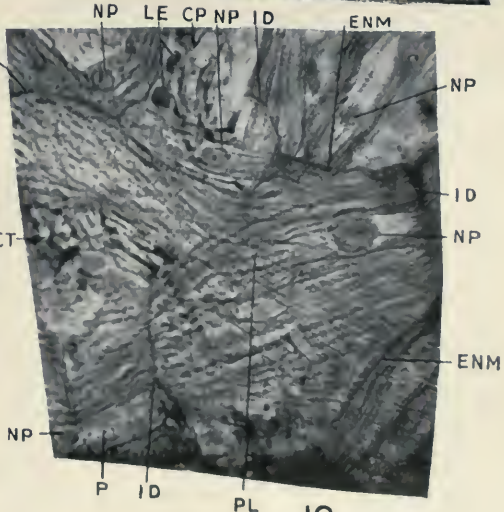
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PL

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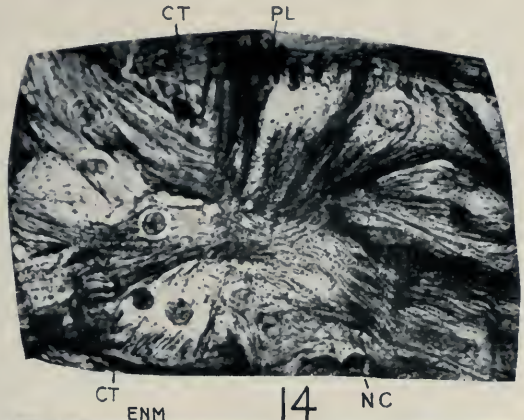

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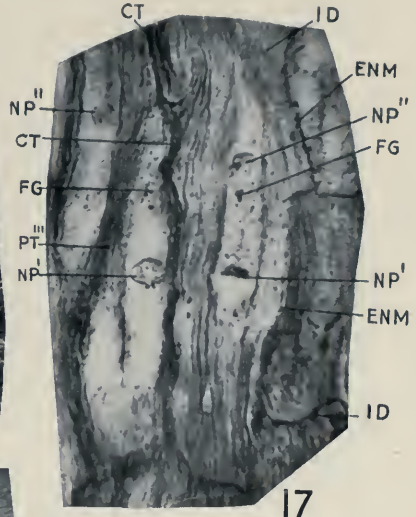

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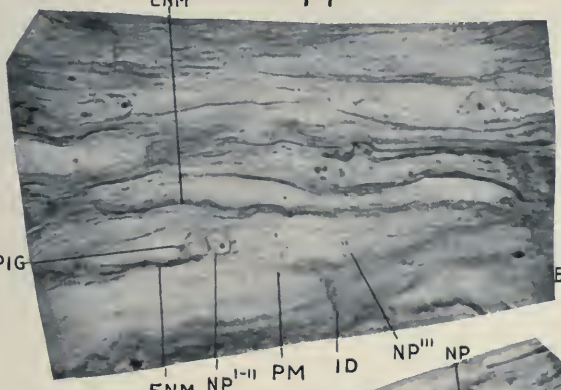

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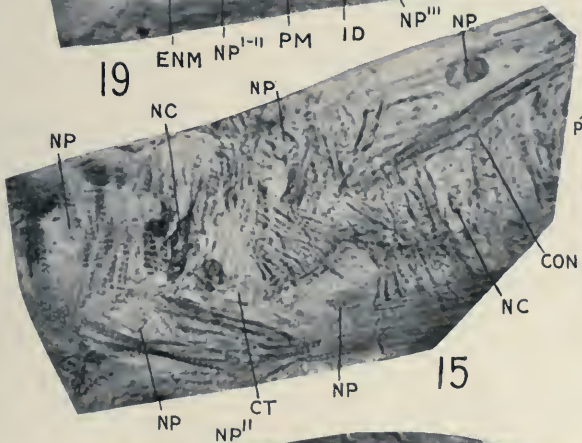

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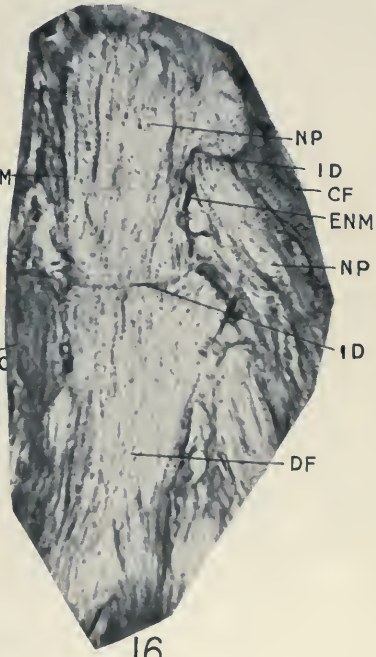

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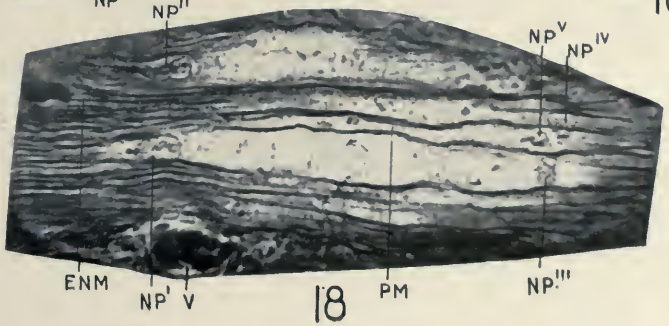

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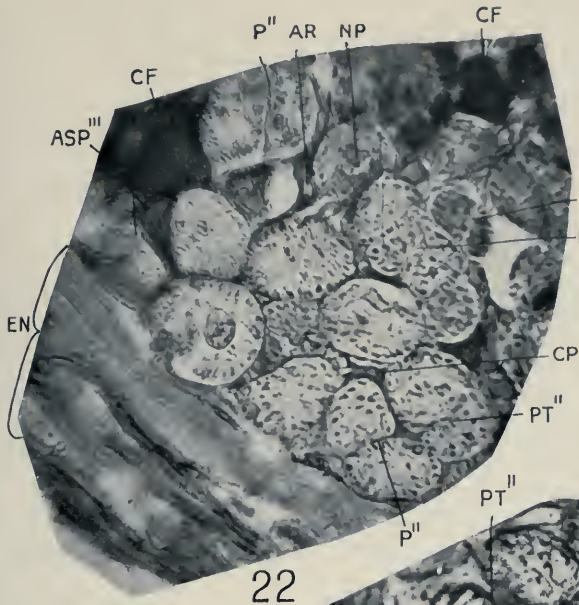
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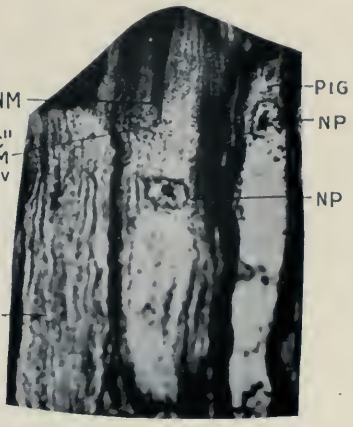
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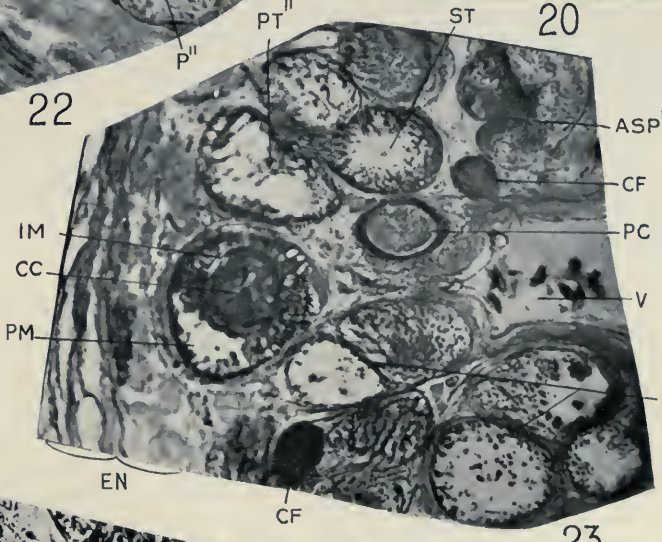
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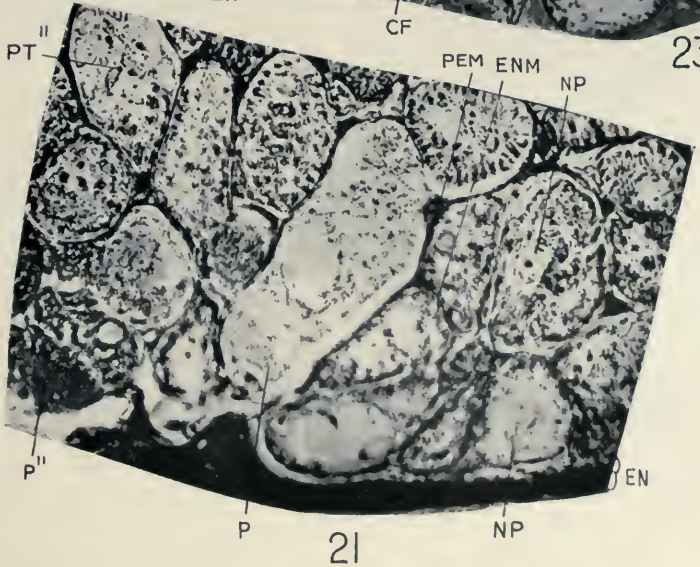
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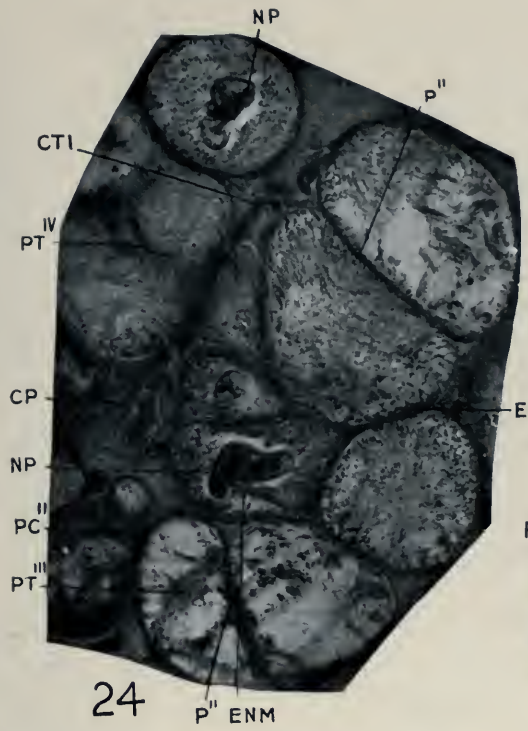
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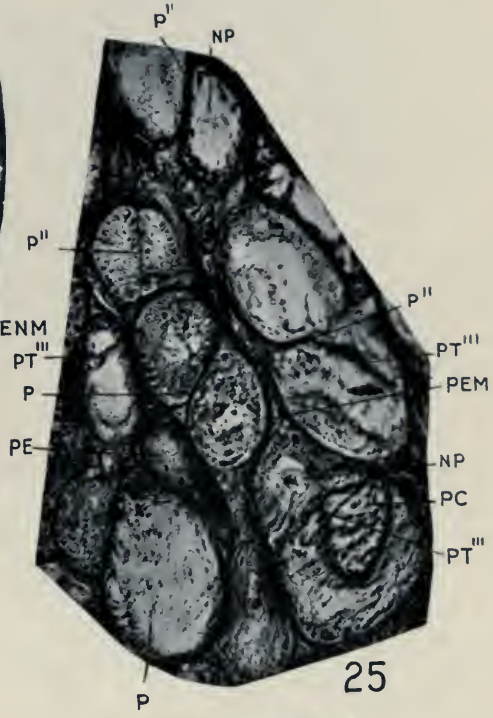
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P

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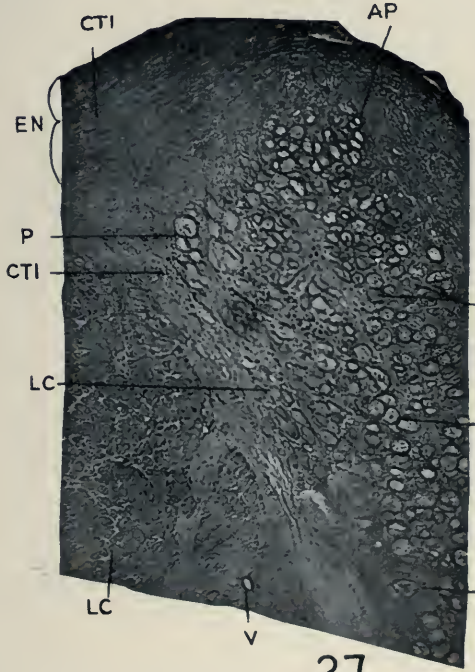
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LC
V

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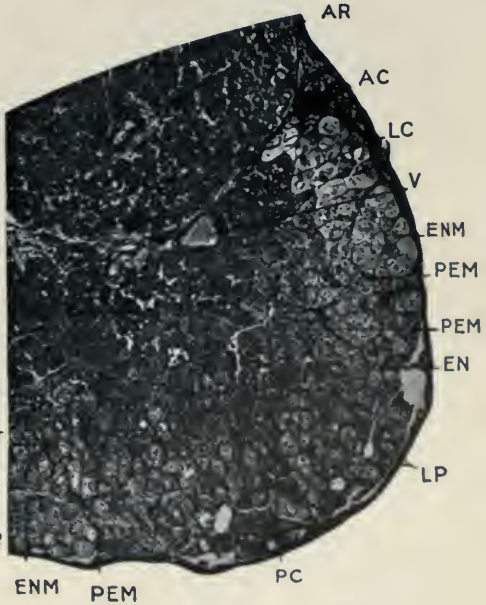
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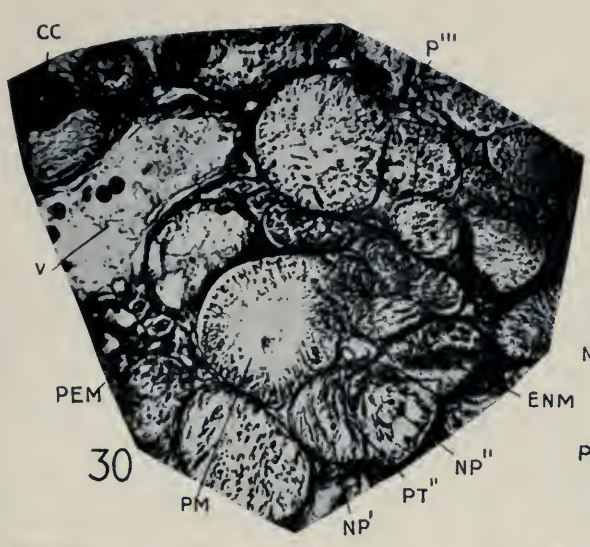
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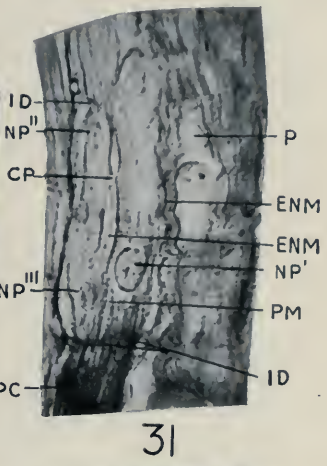
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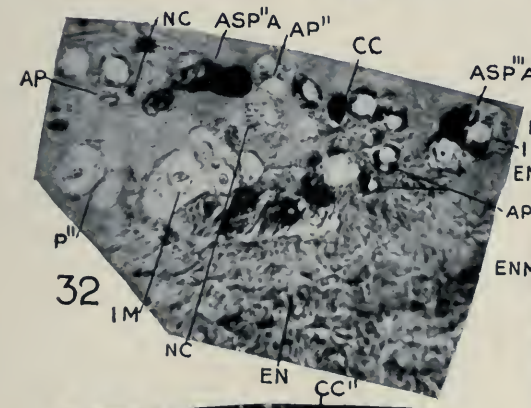
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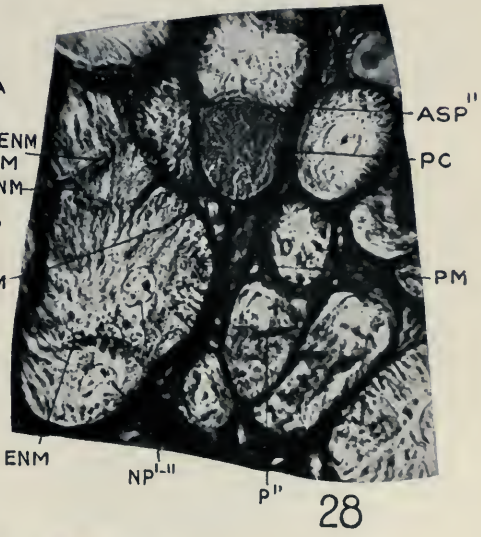
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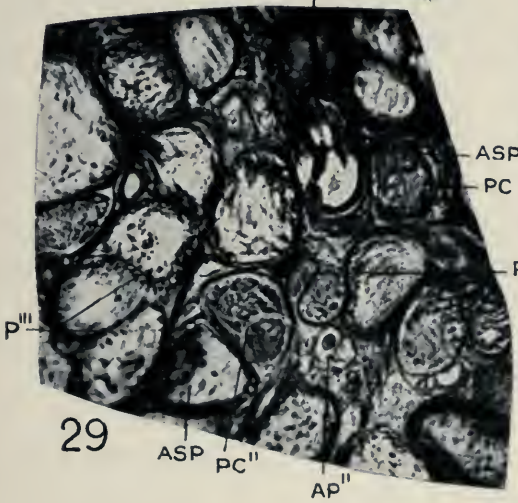
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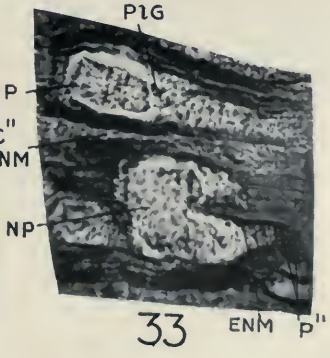
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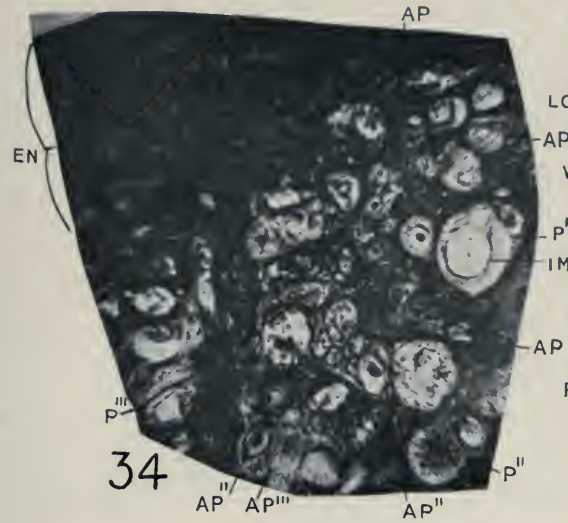

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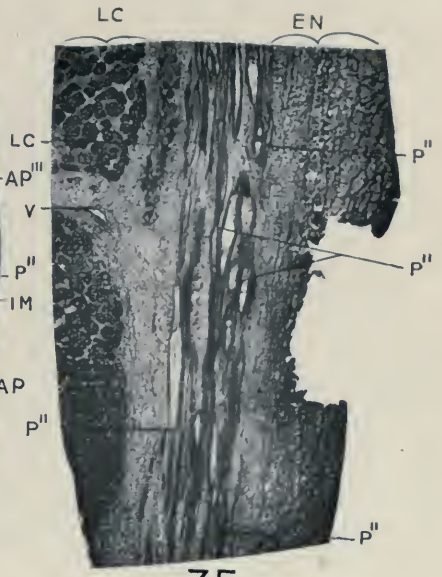

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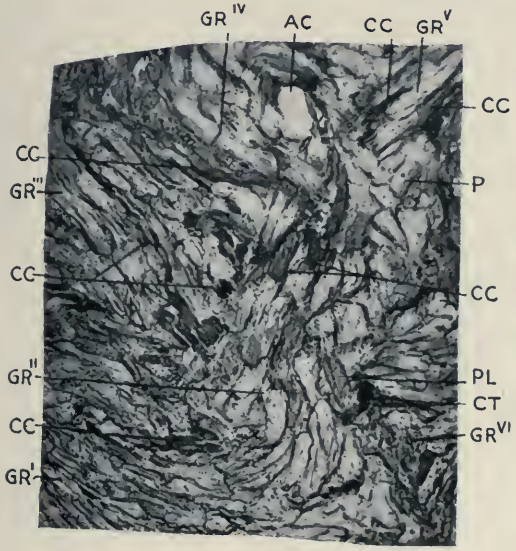

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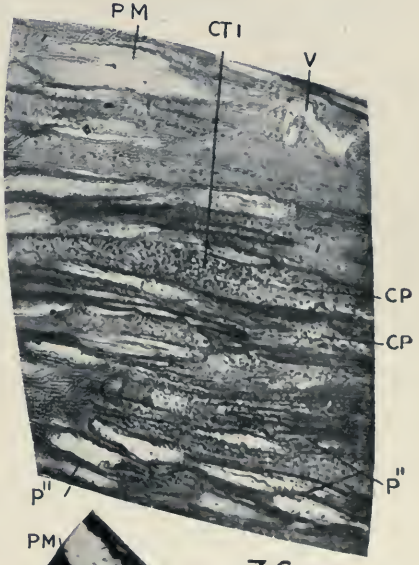

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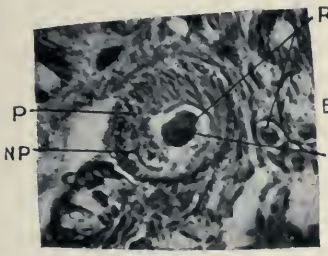

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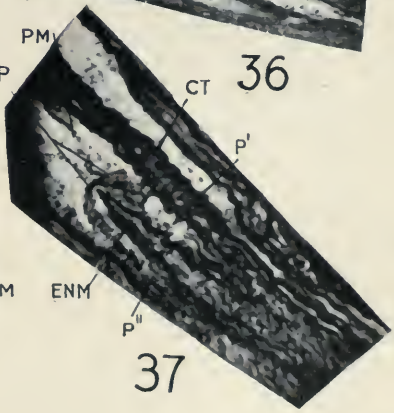

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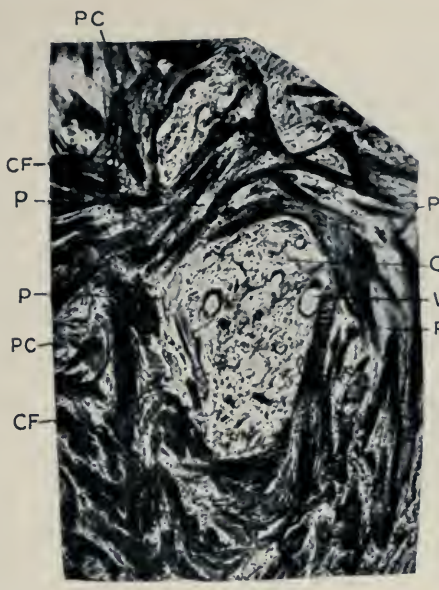
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CTI
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CF

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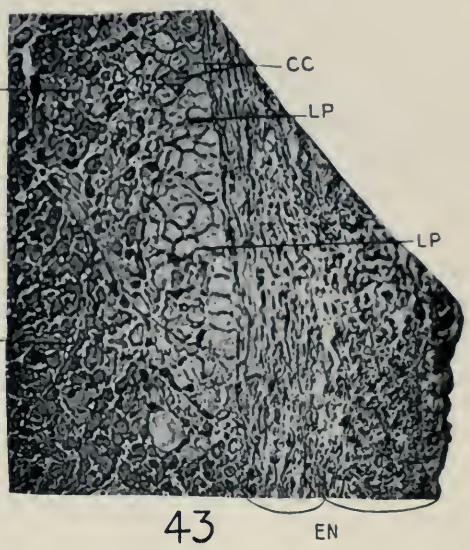
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LC
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43

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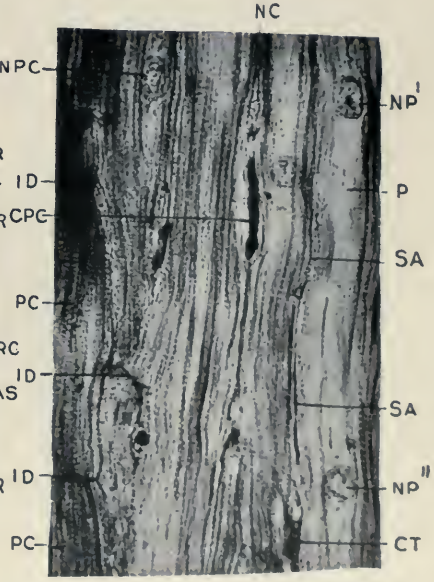
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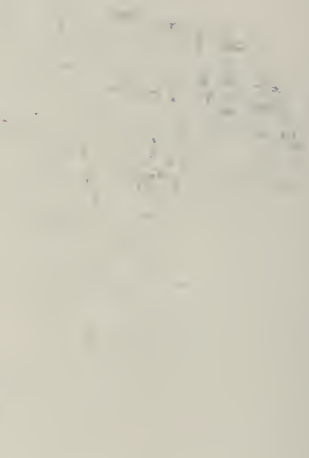
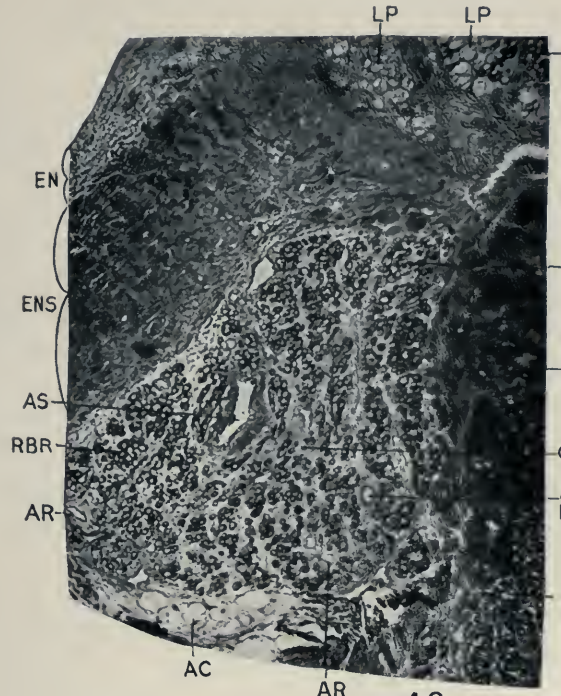
SA
ID
NP II
PC
CT

42

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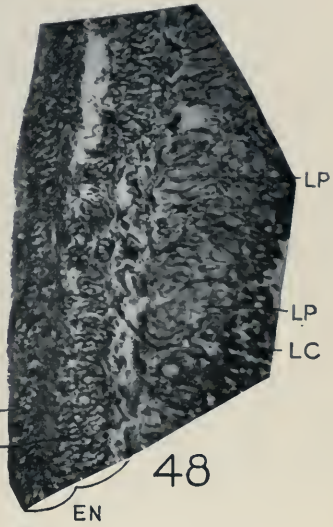
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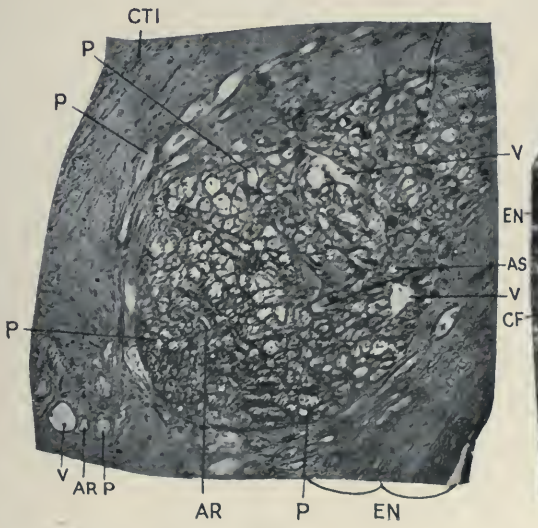
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45

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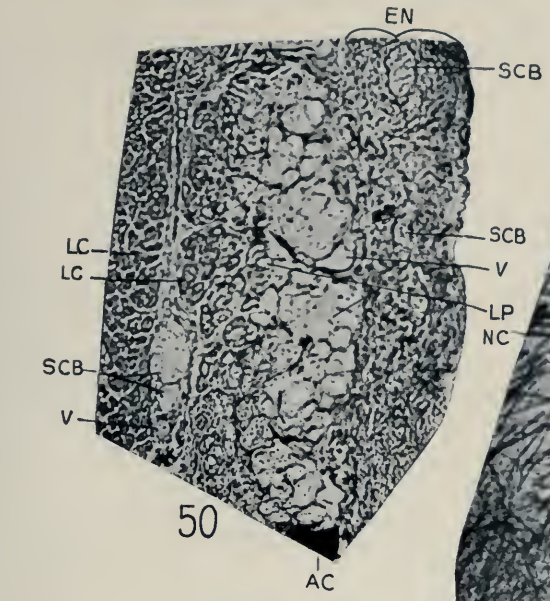
PC

47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SCB
V
AC

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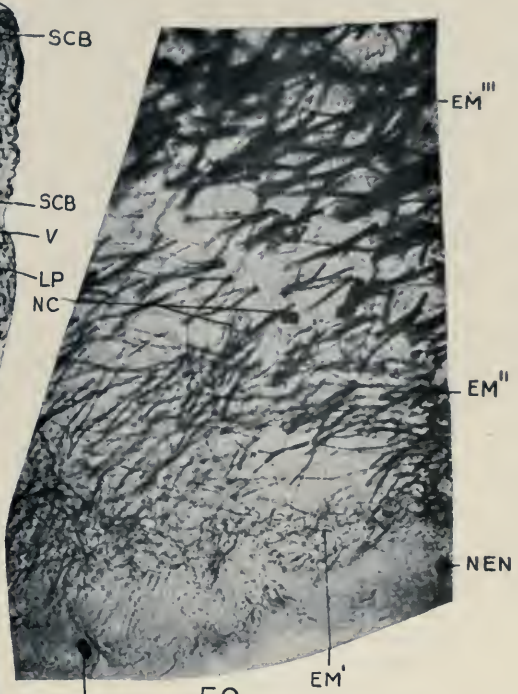
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EM'

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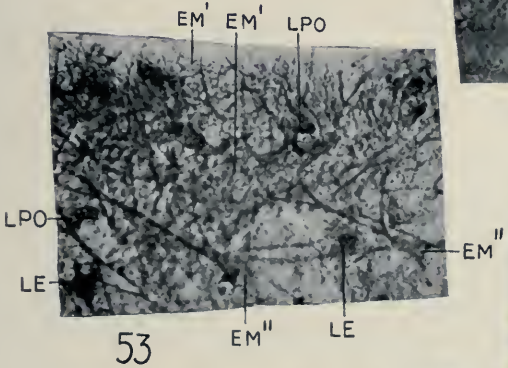
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LE
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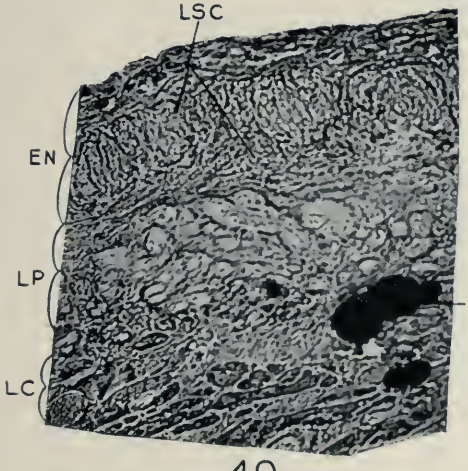
LE

53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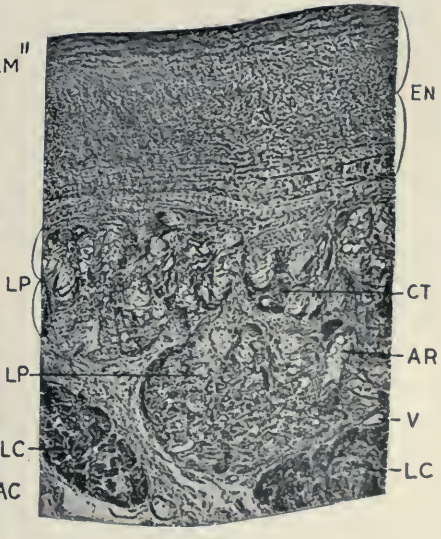
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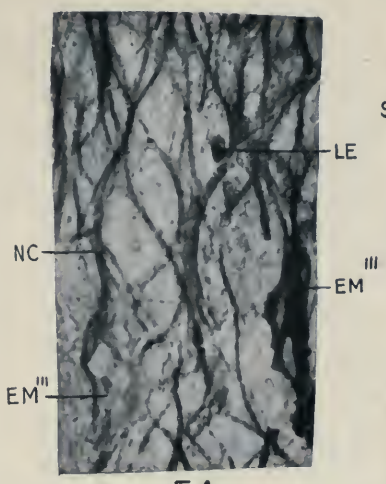

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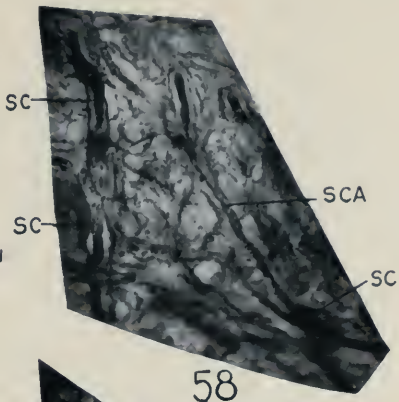

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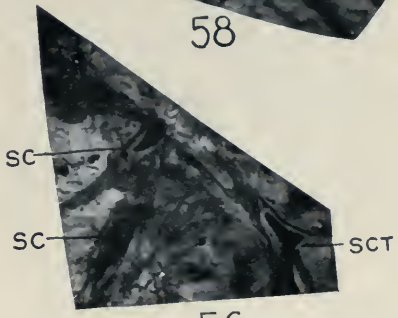

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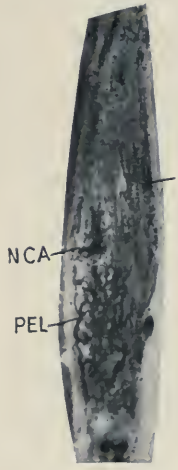

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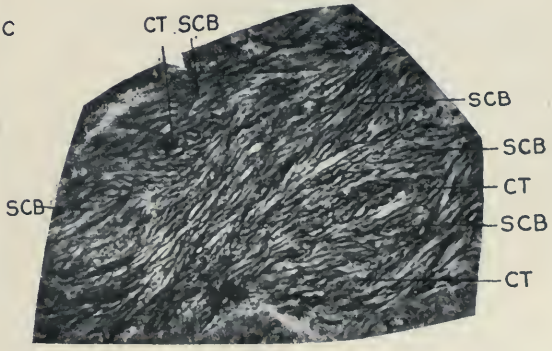

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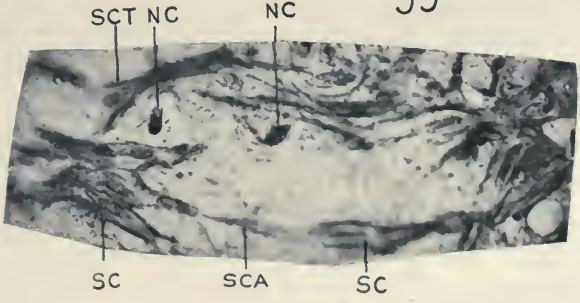

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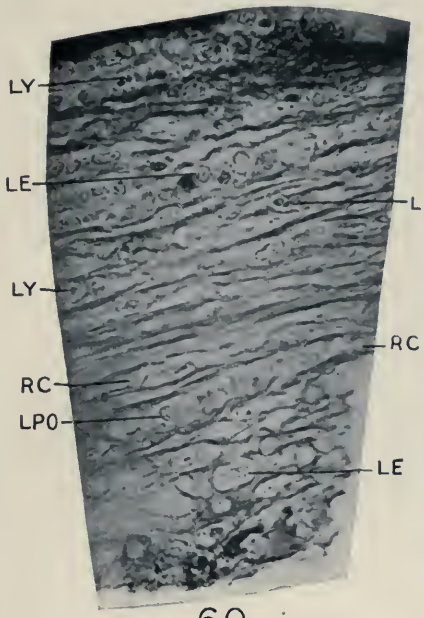

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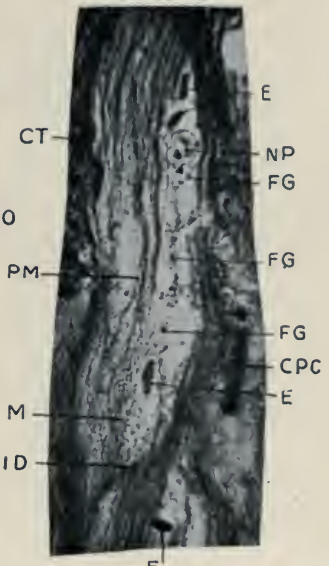

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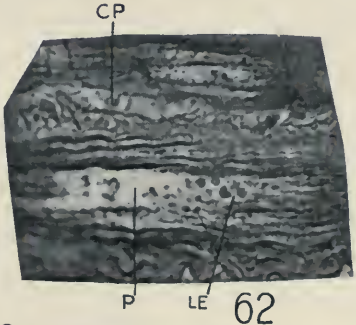
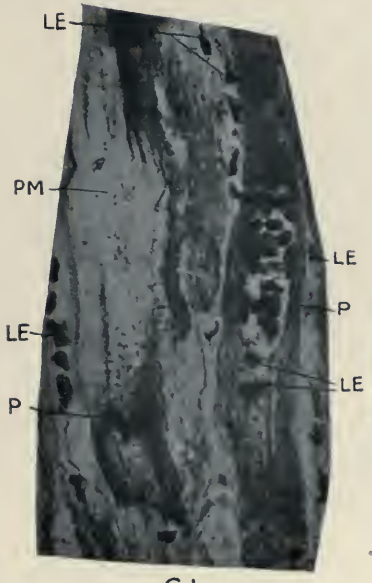
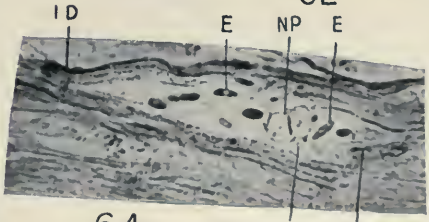


62



61



64

65

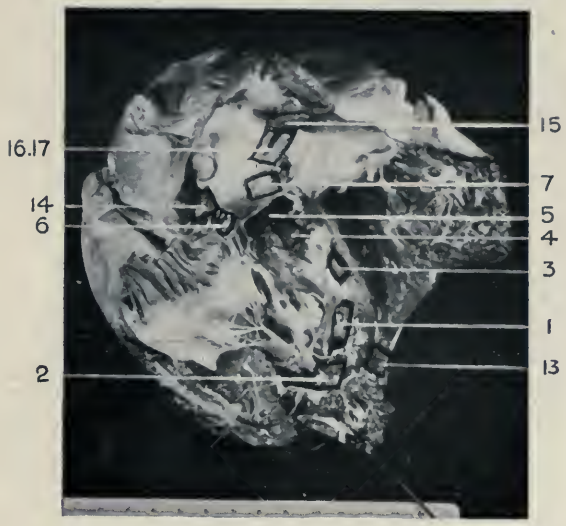


FIG-66.

FIG-67.

THE OPERATIVE STORY OF GOITRE

THE AUTHOR'S OPERATION

By WILLIAM S. HALSTED, Baltimore, Md.

The extirpation of the thyroid gland for goitre typifies, perhaps better than any operation, the supreme triumph of the surgeon's art. A feat which today can be accomplished by any really competent operator without danger of mishap and which was conceived more than one thousand years ago might appear an unlikely competitor for a place in surgery so exalted.

There are operations today more delicate and, perhaps, more difficult, but they have followed naturally and easily in the paths made clear for them. But is there any operative problem propounded so long ago and attacked by so many which has cost so much thought and endeavor and so many lives before its ultimate solution was achieved? And further, is there any problem in surgery having required for its solution such intrepid throbbing and prolonged striving of the world's greatest surgeons which has yielded results so bountiful and so adequate?

For thousands of years, probably, goitre has been a familiar malady. An unsightly and frequently fatal disease, it was accepted as an inoperable affliction or dispensation of Providence in communities where it prevailed, and paraded the streets exciting the curiosity of the populace in towns where it was unusual. The sufferers sought relief from suffocation, difficulty in swallowing, failure of the heart and from a distressing disfigurement. Thus this conspicuous tumor of the neck was a perpetual challenge to the physician, and to the surgeon a stigma as well.

My interest in the thyroid gland may be traced to the time, 40 years ago, when Wölfler was writing his classic monograph on *Die Entwickelung und Bau des Kropfes.*[370] Anton Wölfler, first assistant of Billroth and later professor of surgery in Prague, occasionally came to the laboratory in which I was working in Vienna in 1879 and 1880 to study my sections of the salmon, with reference to the development

and structure of the thyroid gland in the fish. I do not recall, however, having seen an operation for goitre in the clinic of Billroth, which I attended quite regularly.

From 1880 to 1886, the period of my surgical activities in New York, I neither saw nor heard of an operation for goitre, except that in one instance I assisted Dr. Henry B. Sands to extirpate a small tumor from the right lobe of the thyroid gland. The patient, a male, was operated upon in the sitting posture, with a rubber bag to catch the blood tied about his neck. We had only two artery forceps, all, probably, that the hospital afforded, and these were of the mouse-tooth or bull-dog variety (Liston's).

In the autumn of 1887, at the suggestion of Dr. Welch, I began experiments on extirpation and transplantation of the thyroid gland in dogs, which resulted in the discovery, among other things, of the striking histologic changes which signify hyperplasia and hyperactivity of this gland and which apparently are identical with those usually found in Graves' disease. The knowledge thus acquired enabled us early to interpret the microscopic picture of the gland of exophthalmic goitre. The remarkable discoveries by Gley (1891-2)[121] and Vassale and Generali (1896)[244] of the vital importance of the parathyroid glandules stimulated afresh my interest in the surgery of the thyroid gland and suggested experiments in transplantation of the tiny epithelial bodies (Epithelkörperchen). From these experiments there resulted the general law that homografts of these glandules will not live, and that for the successful transplantation of autografts a considerable deficiency must be created. We made the startling and hardly believable observation that the life of a dog may be maintained by a particle of parathyroid tissue only one-quarter of a millimeter in diameter and extinguished by tetany on its removal.

In 1907 Mr. Herbert M. Evans kindly made at my request arterial injections of the parathyroid glandules, and from his and Dr. W. G. MacCallum's careful anatomical studies and my own surgical and experimental observations there resulted an operative procedure in our clinic which I have described on several occasions (1907,[148, 149] 1911,[150] 1912[151]), but perhaps too fragmentarily to attract attention. Inasmuch as we have been unable during the past 12 years to make any essential improvements in our operation, it occurred to me that it might now be well to describe it in greater detail and to give in outline the history of the development of the operation for goitre.

So far as possible I have let the story narrate itself in the words of the principal actors, those chiefly responsible for the operative progress. Surgical performances which seem not to have influenced the development of the operation have been in greater part merely recorded.

I wish to express my thanks and deep indebtedness to Colonel McCulloch and Dr. Fielding Garrison for their great courtesy and assistance. They have granted me very unusual privileges in the use of the Surgeon General's Library, without which and the *Index Medicus* it would not have been possible to conduct the investigation.

To my accomplished secretaries, Miss Stokes and Miss Hough, I can hardly emphasize sufficiently the extent of my obligations for their assiduous and intelligent support. And in the beautifully executed illustrations from the pencil of Max Broedel I have found constant pleasure and a stimulus.

Statistics on the subject of operations, performed the world over, for goitre have from time to time been compiled. The latest collection is Süskind's, who in 1877,[330] reporting 28 operations by Victor von Bruns of Tübingen, was able most favorably to compare his master's work with that of all others and justly to boast of the contributions which German-speaking nations had made to the list of operations for goitre as contrasted with those from the rest of the globe. He makes no mention of a very similar, but less fervidly patriotic paper by Bruberger [58] which antedated his own by about one year. The fundamental historical papers are a tract by Hedenus (Leipzig, 1822),[156] an admirable treatise by Mandt (1832) [232] of Greifswald, and a voluminous chapter by Günther (1864),[144] professor of surgery in Leipzig, in the fifth volume of his *Lehre von den blutigen Operationen am menschlichen Körper.*

HISTORICAL PAPERS

Mandt. *Der Kropf; Geschichte u. Exstirpation desselben,* Rust's Magazin f. d. gesammte Heilkunde, Berlin, 1832, vol. 37, pp. 390, 412, 413.

" The early story of goitre is voluminous, but very tangled. Traces of attempts to distinguish varieties are found with the ancients; later, however, and especially in the Middle Ages, scrofula and other diseases of the glands were confounded with it and synonymously treated. This error was continued until late in the eighteenth century.

" Only in recent, indeed very recent, times have the doctrines on the subject of goitre been put in order by the works of Kortum,[200] Wichman.[361] Webers (Monograph on Scrofula), Maas,[295] von Walther,[349]

Hausleutner,[155] Mühlibach,[358] Hedenus,[156] especially Johannes Müller and others.

"I think it probable that Abul Casem Khalaf Ebn Abbas, usually named Albucasis, undertook about the year 330 * a genuine extirpation of goitre. He lived in Bagdad, was a bold and, one may say, venturesome operator, and could the better hazard the operation because of the following experience: A 'homo ignarus' had attempted a similar operation, and the patient having nearly bled to death from an injured artery Albucasis knew very well how to control the hemorrhage by ligature and the hot iron."

G. B. Günther. In the fifth volume of that scholarly, voluminous, altogether remarkable and today almost unknown work, Günther's *Lehre von den blutigen Operationen am menschlichen Körper,* Leipzig, 1864, 5. Abtheilung, p. 369, the author records in chronological order abstracts of the first 41 cutting operations performed for the removal in whole or in part of "Struma lymphatica," the common form of goitre, covering the period from Celsus to 1861.

"We have used chiefly the treatise by Mandt in Greifswald, Rust's Magazin, vol. 37, p. 411, and that by Hedenus,† *Tractatus de gland. thyreoid.,* Lipsiae, 1822, and, at the same time, corrected some errors which appear in these articles.

"According to Schreger, Celsus had already undertaken the extirpation of goitre. But it is clear from the text that in the chapter which Celsus entitles 'De Struma,' lib. vii, cap. 13, the author, in the use of this term, has not in mind a disease of the thyroid gland, but rather a swelling of the lymph glands. Of goitre proper he speaks in lib. vii, cap. 13, under the title 'De Cervicis Vitio.' Here he describes, unmistakably, cystic goitre, and says, after discussing the use of caustics, 'sed scalpelli curatio brevior est.'

"It is doubtful if the operation mentioned by Galenus, 'De Locis Affectis', (lib. i, cap. 6) comes under this head. See Hedenus, *Tractatus de gland. thyreoid.,* Lipsiae, 1822, p. 288.

* Gurlt (Geschichte d. Chirurgie, vol. i, p. 620) states: "The year of his (Albucasis') birth is unknown. Nevertheless, it is safe to say that he lived in the second half of the tenth century, since it is stated that he was the body physician of Caliph el-Hakim III (961-976). According to the latest investigations of Leclerc (Gaz. hebd. de méd. et de chir., 1874, pp. 537, 569) the statements of the Arab chroniclers that he died in the 404th year of the Hejira, or 1013 of the Christian era, can be accepted as correct (in spite of the assertion of Mich. Casiri, 1766, who says that Albucasis died almost 100 years later, *i. e.*, in the 500th year of the Hejira or 1106-7 A. D.). And if it is true, according to the account of Leo Africanus, that he lived to the age of 101 years, then he must have been born in the year 912 A. D." (W. S. H.)

† Hedenus, Augustus Gulielm, not to be confounded with J. A. W. Hedenus whose operation for goitre is described later in this paper.

"According to Mandt in Rust's Magazin, vol. 37, p. 413; and Langenbeck, Chirurgie, v, p. 306 (note), Albucasis is listed among those who performed this operation about the year 330. In the local library I have not been able to find any passages bearing on this.

"Paulus Ægineta, who lived 400 years later, evidently refers, like Celsus, to tumors of the lymphatic glands when he speaks of amputating strumas. Guy de Chauliac (1363) advocated the extirpation of goitre instead of treatment by 'sympathetical' means.

"Extirpation is next mentioned by Johannes de Vigo (1501 to 1512).

"Mandt, in Rust's Magazin, vol. 34, p. 414, states that Amatus Lusitanus about the year 1550 relates that an 'audax homo' excised small goitres, and thereby exposed the trachea. I therefore consulted the 1557 edition of the works of this author and found only two passages which could be construed as bearing on the extirpation of goitres. One is found in Centur. III, Curatio 56, p. 416, and is entitled 'De Strumis'; the other, in Centur. IV, Curatio 58, p. 597, and is entitled 'De Strumis Dictis Scrofulosis.' But one soon becomes convinced that by the former he means scrofulous abscesses, and by the latter swollen lymph glands.

"It is doubtful whether the accounts of Fabricius ab Aquapendente (1613) and of Marchetti (1664) relate to an extirpated goitre or to swollen glands.

"Joh. Jessen speaks also of an operation on a bronchocele, but he certainly alludes to a swollen gland. Dionis, in his *Cours d'opérations de chirurgie,* 4th edition, 1740, p. 639, after describing struma lymphatica, gives explicit directions for operation. After reading his description of the operation, one doubts whether the author really performed it or only witnessed it.

"According to the account of Mandt, there is an observation by Muralt which makes it seem very probable that an extirpation was accomplished. The communications of Wepfer (1727) and Wiesemann probably relate only to the excision of lymphatic glands. I cannot find anything in Muralt and Wepfer bearing on this operation.

"On the contrary, Forestor, Fulvius Gherli (1710), Petit, Roonhuysen, Hoin, and Conrad Ludwig Walther seem to have excised true goitres. Mandt credits also Joseph Warner. In the translation of the fourth edition, 1787, pp. 83 and 84, I have found only two cases which could possibly be considered under this heading. After reading the full description of these cases I am convinced that they were not goitres.

"Laurentius Heister, 1752, seems to have performed the operation several times, for he says in the second edition of his large *Chirurgie,* vol. ii, p. 659, that he has never found it necessary to use the red-hot iron on account of bleeding. He also describes, in detail, the operative procedure.

"Theden, *Neue Bemerkungen und Erfahrungen, etc.*, new edition, 1776, vol. ii, p. 108, tells of an operation performed by an unnamed physician, with happy result. Mandt speaks of this as a successful case; but it appears that he did not read it in the original, or he could not have alluded to it as an extirpation of an ordinary goitre, for it was clearly a cystic goitre out of which a piece was cut. Desault erroneously credits Theden with an extirpation on account of this operation. It also appears that the case of Kaltschmied in Jena should not be counted among the extirpations. Theden says of this case that Kaltschmied had operated on a similar tumor of the gland, but that the carotid artery ran through it, that this artery was cut in two and that the patient died on the operating table.

"In the *Dissertation* of Zartmann, p. 5, it is stated that Schmucker removed a portion of a goitre. This statement is incorrect. In the second volume of his miscellaneous writings, from which Zartmann quotes, the 23d Observation is entitled: 'Complete Cure of an Enormous Goitre by Dr. Sellin, Military Surgeon' (the case, therefore, does not belong to Schmucker). The operative procedure was in no respect an extirpation; it consisted in the opening and stretching wide of abscesses, caused by severe inflammation of the goitre, whereby, to be sure, the entire enlarged thyroid gland, which contained many bony fragments, by degrees came away.

"Richter in Göttingen did not venture to undertake the operation.

"Boyer declared himself against it, and Fodéré claims to have carried it out only in cases of scirrhous degeneration.

"According to Froriep in Notizen, vol. vi, p. 336, the operation was practised in India.

"In the Dictionnaire des sciences médicales, vol. xviii, p. 555, several instances of extirpation of goitre are mentioned, but they certainly are not all vouched for, and indeed in part are improbable. We quote the following from this treatise:

"'Fodéré asserts that this operation has been performed even by ignoramuses. It is known that intoxicated patients have cut out very large goitres without disaster; in other cases, they have accidentally been cut away without harm by the stroke of a sabre or a knife. Further, Paradin relates, "It is narrated in a chronicle of Savoyen that a barber successfully removed a disfiguring goitre from his wife." Fodéré tells of a courageous surgeon in Marseilles, Giraudy, who successfully removed two goitres.'"

Chronological List of All the Operations which Actually or in All Likelihood have been Performed

"1. In the year 1596 an empiric attempted to remove a goitre in the case of a 10-year-old girl. She died under the operation, and the surgeon was imprisoned. Fabric. Hildanus, vol. ii, p. 399; Fabric. Hildanus, Opera, p. 216, Obs. 35; Langenbeck, Chirurgie, Bd. v, p. 306, footnote.

"2. Johann Heinrich Freitag in Zürich, about 1694; *Epistola de glandulae thyreoideae, partim osseae, partim meliceridis formam referentis exstirpatione,* Lipsiae, 1778; Weiz, *Neue Auszüge aus Dissertationen für Wundärzte,* Bd. iv, p. 66; Langenbeck, Chirurgie, Bd. v, p. 304.

"In a girl of 18 years Freitag extirpated, with success, probably half the thyroid gland. The tumor was almost the size of a goose's egg and could easily be dislodged up to the sternocleido-muscle. A deeply situated vessel, thought to be the right thyroid artery, was ligated. Langenbeck doubts that it was the thyroid gland. The fact that it was so easily movable is suspicious.

"3 and 4. (About 1770.) Benjamin Gooch. S. Cooper, Dictionary, vol. i, p. 301; Bell, System of Surgery, vol. v, p. 525; Richter, Chir. Bibliothek., Bd. ii, Stück IV, p. 128; Langenbeck, Chirurgie, Bd. v, p. 305, footnote; Dictionnaire des sciences médicales, t. xviii, p. 555.

"In one case (3) such a severe hemorrhage occurred that the surgeon was obliged to stop in the middle of the operation. He was unable to control the hemorrhage by any means. The patient died eight days later. Gooch assisted at this operation.

"In the other case (4), after several fruitless attempts at ligation of the arteries, the severe hemorrhage was controlled by compression day and night during eight days by persons alternating with each other at the task. Gooch should have performed this operation, but he declined. It was performed by another skilled surgeon.

"5. Adolph Friedrich Vogel, in his inaugural dissertation (*Observationes quaedam chirurgicae*), Kiel, 1771, reports this operation, but he does not say who performed it. If he had performed it himself he would certainly have said so. Peculiarities in the procedure were the circular incision employed in removing the tumor, and the ligation of the arteries leading into the thyroid gland by a common ligature. I have compared the *Observat. quaedam chirurg.,* Killiae, 1771, quoted by Mandt, but have not been able to find this case.

"6. Desault excised successfully the greater part (so it is said in the text) of an enlarged thyroid gland in the year 1791.* Desault, Chir. Wahrnehmungen, 1794, Bd. v. p. 3. This is probably the case attributed to a Girault by Bernstein (Handbuch der Chirurgie, Leipzig, 1800, Bd. iv, p. 604). There are many errors in Bernstein.

"7. Another operation which Desault performed on a woman is described in the Dictionnaire des sciences médicales, t. xviii, p. 356. After beginning the operation the hemorrhage was so severe that he abandoned the attempt and contented himself with tying up the piece of gland which had been cut. The patient died subsequently of convulsions.

"8. In the time of Desault. Related by Parey in Strasburg. Rullier, Dict. des sci. méd., t. xviii, p. 504; Rust's Chirurgie, Bd. xv, p. 504.

* A complete report of this case is given under the chapter on France.

"In the case of Marquis A., Desault advised operation; Parey and Louis advised against it. The surgeon who had proposed the operation performed it with the assistance of two people whom he came across accidentally. The patient died from hemorrhage on the operating table.

"9. About 1800. Kergel, military surgeon of Saxony. Successful operation. He had to ligate 11 arteries. Bernstein Handbuch d. Chir., Leipzig, 1800, Bd. iv, p. 405; *ibid.*, 5. Aufl., 1818, Bd. i, p. 752; Langenbeck, Chirurgie, Bd. v, p. 305.

"10-15. J. A. W. Hedenus in Dresden (about 1800). Six times with good results.* Journ. von Walther und Graefe, Bd. ii, p. 236.

"16. Bonnet, surgeon in Clermont-Ferrand. Year unknown. Brun, *Dissertation inaugurale sur le goître,* 1815, p. 16; Dict. des sci. méd., t. xviii, p. 564; Rust's Handb. d. Chir., Bd. xv, p. 504. The patient died from hemorrhage.

"17. Ohle, Prof. der Chir. Academie in Dresden. Successful. Hedenus, *Tractatus de gland. thyreoid.,* 1822, p. 291.

"18. Weiss in Dresden, successful. Hedenus, *l. c.*

"19. Dupuytren,† Jan. 1, 1808. Pelletan, Clin. Chirurg., vol. i, p. 215. Death after 35 hours. Seventh Obs., Paris, 1810; Dict. des sci. méd., t. xviii, p. 557; Rust's Handb. der Chir., Bd. xv, p. 504. Related in greater detail; Dupuytren, Clinique chirurgicale, t. i, p. 215, Obs. 7, Paris, 1810. Adelaïde Michon, *æt.* 28. Jäger, Walther und Radius, Bd. vi, p. 548, give this case and case No. 33 of this article as one and the same, while the reference here given by Pelletan and the reference in case 33 taken from Froriep's Notizen is regarded as one and the same story. The two cases, to be sure, have many points in common, but the two operations were certainly performed in two entirely different periods.

"20. Langenbeck in Göttingen (year unknown). Langenbeck, Chirurgie, Bd. v, p. 303.

"Since Langenbeck in the very full chapter on 'Struma,' declares himself, on the whole, more against than in favor of the operation, and also gives only very general rules for the same, one would doubt that he had himself operated if he had not said explicitly in Anm. 3: 'At the extirpation which I accomplished I found not the least difficulty in ligating the arteries.' I have not been able to find out anything about the result.

"21. 1820, Graefe in Berlin, Jan. 19. Hedenus, *Tractatus de gland. thyreoidea,* Lipsiae, 1822, p. 276; Journ. von Walther und Graefe, Bd. ii, p. 388. He had some time previously ligated the thyroid artery and removed only the greater part of the gland. Fifty-three arteries were ligated. The result was good.

* Paper of Hedenus is abstracted in chapter on Germany.

† For abstract see chapter on France.

"22, 23. Graefe. Hedenus states (*l. c.*, p. 292) that besides the above-mentioned case, Graefe has twice performed the operation successfully.

"24. Eichenberg, a Swiss, extirpated the gland without excessive bleeding. It is, however, doubtful whether this was the thyroid gland, although he asserts that after the operation the larynx and the trachea were exposed. Epheremid. med. physic. germ. acad. Natur. curios., Dec. ii, Anm. v, p. 453; Langenbeck, Chirurgie, Bd. v, p. 304.

"25. Klein * in Stuttgart, Journ. von Graefe und Walther, Bd. i, p. 120, undertook the operation in a boy of 15 years (1815). The patient died directly after the operation.

"26. Klein. On p. 130 he tells of a second operation, but it is doubtful if he extirpated the thyroid gland. He had only three arteries to ligate. The patient lost his voice during the operation, and developed great difficulty in swallowing. These symptoms disappeared very slowly after the ligatures came away.

"27. Klein. The third operation was performed on a man aged 22 years (p. 133). A very severe hemorrhage occurred, but the patient recovered, nevertheless.

"28. Hermann Schmidt in Paderborn. Zartmann, *Dissertation,* p. 26.

"29. Roux. Took out half the gland. Death. *Ibid.*

"30. About 1829, Green, at St. Thomas's Hospital. Extirpation of the right lobe in Maria Gale, *æt.* 24, on May 22. Death June 6. The Lancet, No. 302; Froriep's Notizen, Bd. xxv, p. 95.

"31. May 21, 1829. Walther. Removed half the gland. Patient Catherine Nath, *æt.* 28. Recovery. Chir. Handwörterbuch von Walther, Jäg. u. Rad., Bd. ii, p. 542; Zartmann, *Dissertation,* p. 26.

"32. Aug. 11, 1829. Walther. Removed half the gland. Patient, Elsie Hartung, *æt.* 34. Recovery. Chir. Handwörterbuch von Walther, Jäg. u. Rad., Bd. ii, p. 542; Zartmann, *Dissertation,* p. 22.

"33. About 1831. Nov. 22. Dupuytren. Froriep's Notizen, Bd. xxix, p. 141. Girl of 12 years. Death the next day at 3 a. m.

"34. About 1832. Mandt in Greifswald. Patient Charlotte Schneider, *æt.* 34. Recovery. Rust's Magazin, Bd. xxxvii, p. 387.

"35. About 1834. Professor Franke in Leipzig, with the assistance of Professor Boek. Verbal report.

"36.† March 26, 1835. Roux. Operated on Girard Gourvain, *æt.* 22. Forty-seven ligatures were applied. The operation lasted 1½ hours. Arch. géner., 1836; Schmidt's Jahrb., Bd. xi, p. 58. Detailed with full autopsy account; Oppenheim, Zeitschrift ii, p. 519. Short account. Death after two days.

* For full account see chapter on Germany.

† Abstracted in chapter on France. Interesting because the patient was venesected while dying from result of hemorrhage at the operation. Venesection was not infrequently practised on exsanguinated patients.

"37. 1844-1846. Reported by Madelung in Gotha. Probable Recovery. Aerztlicher Verein in Gotha, 1844-46; Schmidt's Jahrb., Bd. lvi, p. 279.

"38. Bruns in Tübingen. Deutsche Klinik, 1859, p. 145, Fall 3. Gurlt, Jahresbericht von 1859, p. 186. Successful.

"39, 40. About 1861. Züricher Krankenhaus. Struma lymphatica twice successfully extirpated. Deutsche Klinik, 1861, p. 167.

"41. N. Pirogoff. Rapport médical d'un voyage en Caucase et St. Petersbourgh, 1849; Schmidt's Jahrbücher, Bd. lxvii, p. 117. In a girl of 17, with the administration of ether. The middle lobe was the size of a goose's egg and pressed on the trachea. Thirty arteries were ligated. Operation lasted half an hour. Result not stated.

"42. R. V. A. Schmidt tells of the extirpation of a goitre in a horse with the écraseur. Cure. Reported by Falke in Jena. Schmidt's Jahrb., Bd. cix, p. 346."

Thus the story is carried by Günther to 1861. He collected 41 cases, but overlooked 65 (France, 17; Italy, 13; Great Britain, 12; United States, 8; Germany, 15), operated upon prior to this date, which are abstracted in our tables. Many of these cases were, however, published in journals to which Günther hardly could have had access; and some were merely ligations of thyroid arteries which Günther did not attempt to collate. Most important, perhaps, of the omitted cases are Nathan R. Smith's (1835) [223] and E. S. Cooper's (1860).[55] The operations prior to 1861 were chiefly resections of portions of the gland or enucleations of more or less circumscribed nodules or ligations of one or two thyroid arteries. There were, however, several remarkable lobectomies which will be considered later under the geographic headings.

Operations Prior to 1861 Not Tabulated by Günther

FRANCE

Nélaton: Bull. soc. anat. de Paris, s. 3, i, 100.

Blandin: Ferrus, Dict. de méd. ou répertoire gén. des sci. méd., Paris, 1836, 2e éd., xiv, 181.

Voisin: Gaz. méd. de Paris, 1836, s. 2, iv, 372.

Bach: Hirtz, Gaz. méd. de Paris, 1841, s. 2, ix, 9.

Rigal, R.: Bull. gén. de thérap., méd. et chir., Paris, 1841, xxi, 224.

Ballard: Arch. gén. de méd., Paris, 1846, s. 4, xi, 222.

Roux: Petit, Bull. soc. anat. de Paris, 1848, xxiii, 205.

Bégin: Bull. de l'acad. nat. de méd., Paris, 1849-50, xv, 1110.

Roux: *Ibid.*, p. 1106.

Sédillot: 3 cases, *ibid.*, p. 1132.

Cabaret: Gaz. méd. de Paris, 1850, s. 3, v, 710 (communiqué par Dr. Velpeau).

Alquié: Annales cliniques de Montpellier, 1854, ii, 222. Also reported by Barbin, Thèse de Montp., 1854, p. 26.

Dunglas: Gaz. méd. de Paris, 1856, s. 3, xi, 129.

Chassaignac: Foucart, La France méd. et pharm., Paris, 1860, vii, 284.

ITALY

Marzuttini, G. B.: Bull. d. sc. med. di Bologna, 1846, s. 3, ix, 365.

Porta, L.: Delle malattie e delle operazioni delle ghiandola tiroidea, Milano, 1849. Articola II, Cura chirurgica, p. 135.

Ibid., p. 135.
Ibid., p. 136.
Ibid., p. 139.
Ibid., p. 149.
Ibid., p. 150.
Ibid., p. 151.
Ibid., p. 152.
Ibid., p. 153.
Ibid., p. 154.
Annali Universali di Medicina, 1850, cxxxvi, 5.

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GREAT BRITAIN

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At this juncture we may, opportunely, quote the views, current at the time (the middle of the nineteenth century), of a few of the world's leading surgeons on the subject of operating for goitre.

Robert Liston.* *Lectures on the operations of surgery, and on diseases and accidents requiring operations.* With numerous additions by Thomas D. Mütter, Philadelphia, 1846, p. 318.

"It has been proposed, again, to cut these tumors out, and some surgeons have ventured upon that, but the result has not been at all satisfactory. You could not cut the thyroid gland out of the living body in its sound condition without risking the death of the patient from hemorrhage; and when that body has become hypertrophied to an immense extent, and all the veins and arteries are enormously enlarged, you can easily understand what dangers may arise from any attempt of the kind. Look at the foregoing sketch, and think of the dangers that must encompass you on all sides, and you will pause before undertaking such a task as the extirpation of the thyroid body. It is a proceeding by no means to be thought of."

Johann Friedrich Dieffenbach.† *Die Operation des Kropfes. Die Operative Chirurgie.* Leipzig, 1848, vol. ii, pp. 331 and 340.

"The operation for goitre is one of the most thankless, most perilous undertakings, which, if not altogether prohibited, should at least be restricted to certain varieties of the malady.

* Robert Liston (1794-1847) was a pupil of Sir William Blizard (in 1816), who was the first to ligate the superior thyroid artery (publication in 1811); he taught anatomy with Syme, his younger rival; was a member of the Council of the Royal College of Surgeons, F. R. C. S., 1841.

Obituary notice, London *Times*, Dec. 20, 1847 (Dictionary of National Biography): "Liston's claim to remembrance is based upon the marvellous dexterity with which he used the surgeon's knife, and upon the profound knowledge of anatomy which enabled him to operate successfully in cases from which other surgeons shrank. Living at a time immediately antecedent to the introduction of anesthetics, he appears to have attained to a dexterity in the use of cutting instruments which had probably never been equalled, and which is unlikely to be surpassed. When chloroform was unknown it was of the utmost importance that surgical operations should be performed as rapidly as possible. Of Liston it is told that, when he amputated, the gleam of his knife was followed so instantaneously by the sound of sawing as to make the two actions appear almost simultaneous, and yet he perfected the method of amputating by flaps."

† "Die Operation des Kropfes ist eine der undanksbarsten, lebensgefährlichsten, und wenn auch nicht ganz aus der operativen Chirurgie zu verbannen, doch nur auf gewisse Kropfarten zu beschränken.

"Wenn wir nun alles, was wir aus den Werken der Schriftsteller über die Operation grosser, gleichmässig harter, oder selbst scirrhöser Kröpfe wissen, nochmals überblicken, so müssen wir mit Schaudern an diese tollkühnen Unternehmungen denken."

"If, now, we again review all that we know from the writings of authors concerning operations upon large, uniformly hard or indeed scirrhous goitres, we can only regard with tremulous aversion these foolhardy performances."

Samuel D. Gross. *A system of surgery.* Philadelphia, 1866, 4th ed., vol. ii, p. 394.

"When the tumor resists our curative efforts, and endangers suffocation, it has been proposed to afford relief by extirpation; but the question arises, is such a procedure proper or justifiable? In a word, can the thyroid gland, when in a state of enlargement, be removed with a reasonable hope of saving the patient? Experience emphatically answers, no. This conclusion is not invalidated by the fact that the operation has, in a few instances, been successfully performed. By no means. It only proves that an undertaking may occasionally be accomplished under circumstances apparently the most desperate. What has once been effected may be effected again. But no sensible man will, on slight considerations, attempt to extirpate a goitrous thyroid gland. If a surgeon should be so adventurous or foolhardy as to undertake the enterprise, I shall not envy him his feelings while engaged in the performance of it, or after he has completed it, should he be so fortunate as to do this. Every step he takes will be environed with difficulty, every stroke of his knife will be followed by a torrent of blood, and lucky will it be for him if his victim live long enough to enable him to finish his horrid butchery. Should the patient survive the immediate effects of the operation, if thus it may be called, death will be almost certain to overtake him from secondary hemorrhage, or from inflammation of the cervical vessels, esophagus and respiratory organs. When the tumor is large, the wound is of frightful extent, involving all the most important and delicate structures of the neck, and rendering it altogether improbable, from the constant motion of the windpipe and esophagus, that much of it will unite by first intention. Thus, whether we view this operation in relation to the difficulties which must necessarily attend its execution, or with reference to the severity of the subsequent inflammation, it is equally deserving of rebuke and condemnation. No honest and sensible surgeon, it seems to me, would ever engage in it."

John E. Erichsen. *The science and art of surgery.* American edition. Philadelphia, 1873, vol. ii, p. 367.

"I have more than once been tempted to remove large, pendulous, pedunculated bronchoceles, but close examination has satisfied me in all cases that the pedicle of the tumor was so vascular, containing large arterial and venous branches, and so intimately connected with the sheath of the carotid, stretching under the sternomastoid, which was expanded over it, that no operation could be safely undertaken.

In the event of its being thought desirable to operate, the better plan would be, after exposing the tumor by a straight incision, to enucleate it as much as possible with the handle of the scalpel, ligaturing carefully all the vessels divided as they were cut."

Th. Billroth. *Geschwülste der Schilddrüse.* Chirurgische Klinik, Zürich, 1860-67. Berlin, 1869, p. 179.

Billroth, in 1869, having performed 20 extirpation operations for goitre with eight deaths, writes:

"To him who has had little practice in these operations it can easily happen that he removes the entire half of the gland instead of merely the tumor, whereby the operation becomes very complicated and more dangerous. The extirpation of the entire gland is not so exceedingly difficult and can be accomplished without great bleeding; but whether human beings can survive it has not yet been determined."

The deaths following Billroth's operations were due to infection, only one patient dying of "collapse" (hemorrhage?).

The views of other surgeons will appear later in the pages devoted to their contributions.

Bruberger. *Ueber die Exstirpation des Kropfes, nebst einem geheilten Fall von Totalexstirpation einer grossen, mit breiter Basis aufsitzenden Struma hyperplastica und statistischen Bemerkungen.* D. militärärztl. Zeitschr., Berlin, 1876, Jahrg. 5, p. 447.

In 17 pages Bruberger condenses the story of the surgical treatment of goitre from 1785 to 1876. The important work of Günther he undoubtedly overlooked, as no mention is made of it. For the extirpations from 1785 to 1845 he accepts Brière's collation from Schmidt's Jahrbücher (*l. c.*). From 1845 to 1876 the study is original and possibly furnished to Süskind material for his monograph of the following year.

A very creditable and successful case of Küster's, which Bruberger publishes in detail, gave the incentive for his work. A "total extirpation" in a difficult case was performed by Küster in the Augusta Hospital, Berlin, on May 4, 1875. In January and May of the following year the patient was examined by Bruberger, who found him in perfect health and with voice unaffected. In the strict sense of the term this operation of Küster's was probably not a total extirpation, for I note that the broad base or pedicle of each lobe was perforated in several places and tied off in masses. Had no thyroid tissue been left to the patient it is more than likely that such a procedure would have

caught the recurrent nerve and probably have cut off the circulation of the parathyroid glands. As there was neither tetany nor cachexia strumipriva nor laryngeal paralysis, it is probable that the patient (male, *æt.* 18) was not entirely deprived of his thyroid gland.

Bruberger tabulated 124 cases. In 82 it could not be determined that anything more than the "goitre" had been excised; of these patients, 28 died and 54 recovered.

"In 17 cases," he writes, "the entire degenerated gland was certainly removed; of these only two died. In 25 cases it is expressly stated by the authors that only degenerated portions were removed; of these, five died.

"The mortality from goitre-extirpations, according to the published reports, amounts to 29 per cent."

In Bruberger's table the 17 total extirpations are assigned as follows: Lücke, 2; Greene, 3; Watson, 6; Kocher, 2; Hopmann, 1; Michel, 1; Dupuytren, 1; Roux, 1.

By reference to the notes which we have made of these cases from the original sources I am convinced there is no evidence that the entire thyroid gland was removed in any one of them except Kocher's. Sick's [320] case is regarded by Bruberger as a partial extirpation. This is probably an error, for from Sick's description of the operation it seems quite certain that the entire gland was removed; furthermore, the patient developed symptoms of thyroid privation—*the first recorded case of status thyreoprivus.*

It would indeed be strange if 17 complete extirpations had been accomplished by the comparatively rough methods of the earlier, relatively inexperienced, surgeons without resultant tetany or cachexia strumipriva or injury to the recurrent nerve, when later operators with vastly greater experience and better technical equipment had such disastrous sequelæ from their total excisions. Thus Kocher, in 1883,[193] states that of 18 patients, out of 34 with total excision who returned for examination, only two were free from the symptoms of cachexia strumipriva. In three of Mikulicz's total excisions (1886) [249] of the thyroid gland, tetany occurred; and in one of the cases of tetany, cachexia strumipriva developed later.

In 1883 Weiss [359] reported eight cases of tetany from Billroth's clinic; he does not, however, give the number of Billroth's total lobectomies at that time. But the previous year Wölfler [369] reported these as 22, with two post-operative deaths.

Notwithstanding much speculation on the subject by various authors, it has not been made clear why Kocher's cases of cachexia strumipriva should have been so free from tetany, nor why Billroth's total extirpations should have been so frequently followed by tetany and should have so seldom manifested symptoms of thyroid deprivation. I have pondered this question for many years and conclude that the explanation probably lies in the operative methods of the two illustrious surgeons. Kocher, neat and precise, operating in a relatively bloodless manner, scrupulously removed the entire thyroid gland, doing little damage outside of its capsule. Billroth, operating more rapidly and, as I recall his manner (1879 and 1880), with less regard for the tissues and less concern for hemorrhage, might easily have removed the parathyroids or at least have interfered with their blood supply, and have left fragments of the thyroid. Surprising, however, is the fact that the function of the parathyroids was so seldom interfered with by Kocher, notwithstanding his careful procedure; for these little bodies were entirely disregarded by surgeons until years after the discoveries of Gley (1891) [131] and Vassale and Generali (1896).[344]

Bruberger writes: "Besides Lücke, who, quite beyond question, ranks first as authority in the province of the surgical treatment of goitre, and who as early as 1870 declared himself in favor of excision, there are several surgeons who, very recently, have rendered conspicuous service in matters pertaining to the technique of goitre-extirpation. These are the American Greene, the Englishman Watson, our German fellow-countryman Kocher and the Frenchman Michel. In the preceding pages, I have furnished proof that the surgical authorities of all countries have almost up to the present time contributed to the placing of a ban upon the excision of goitre; it is therefore permissible to point out, in connection with the above names, that the voices which now are asking that this adverse verdict be set aside are from Germany, England, France and America, and, accordingly, that the reintroduction of goitre-extirpation as an operation which is justifiable and deserving of a place of honor has international support.

"Watson practises the following original method, which he has had opportunity to test in six cases: He divides the soft parts by a long incision in the midline, passes the index finger round the upper and lateral edge of the struma and carries a threaded aneurism-needle beneath the gland from the middle of the upper to the middle of the lateral edge. When this thread is tied, about one-fourth of the vessels leading into the gland are shut off. In the same way the needle is passed three times beneath the remaining quarters of the gland, and after all the threads are tied, the tumor is severed from its connections by means of curved scissors.

"Greene divides his procedure, which he has practised in three cases, into four operative acts: (1) Exposure of the struma by a long, straight incision, avoiding any wounding of the tumor or of its fascia; (2) division of the fascia of the tumor on the director; (3) retraction of the fascia and enucleation of the tumor with the fingers and the handle of the scalpel—disregarding the bleeding, the operator advances quickly to the base in order to compress the thyroid arteries; (4) transfixion and double ligation of the pedicle.

"Kocher, who has already reported 13 cases of goitre-extirpation—among them two cases of cure by total extirpation—practised in four cases the enucleation described by him."

Thus, with generous courtesy, Bruberger divides the honors of the early triumphs in the surgery of the thyroid gland almost equally between Germany, England, France and America, mentioning after Lücke, the name of one surgeon for each country—Kocher for Switzerland, Watson (Edinburgh) for England, Michel for France and Greene for America; and this, too, at a time when for Germany he might have mentioned, among many, the names of Hedenus, von Walther, von Bruns and Billroth, and probably could not from his knowledge have credited America with any one besides Greene, nor Great Britain with any one except Watson. The names of Desault, Dupuytren and Sédillot for France he should not have overlooked. Süskind, truer to the facts, waves ardently, a year later, the colors of his country.

Adolf Süskind. *Ueber die Exstirpation von Strumen.* Inaugural-Abhandlung, Tübingen, 1877.

Süskind continues the operative story introduced so comprehensively by the scholarly Günther and carried by him from the beginning of the Christian era to the middle of the nineteenth century. He makes no mention of Bruberger's paper of the preceding year.

The contrast between the adverse sentence visited by surgical authors with few exceptions upon extirpatio strumæ and the favorable results obtained by Victor von Bruns in the surgical clinic at Tübingen gave Süskind the incentive to submit to critical review the cases theretofore published. For the history of the earlier period he makes due acknowledgment to the work of Günther (*l. c.*), and to Michel (1873)[244] for his collection of cases operated upon in France. Quite justly he makes the claim that from the end of the eighteenth century to the date of his thesis (1877) the operative work upon the thyroid gland was performed chiefly by German surgeons. Notwithstanding this,

BRUBERGER'S STATISTICAL SUMMARY OF GOITRE-EXTIRPATIONS TO 1876

Operator	No. of cases	Cured	Died	Total extirpations of whole thyroid gland	Partial extirpations (whole gland not affected)	References
Operations, 1785-1845	29	18	11	....	....	Schmidt's Jahrbücher, collected by Brière.
Walther	2	2	..	....	....	Zartmann: De Strumae exstirpat. Dissertation, Bonn.
Bruns	5	3	2	....	....	Werner: Chir. Behandl. d. Strumen. Dissert., Tübingen, 1853. Klein: Behandl. der Strumen. Dissert., Tübingen, 1860.
Emmert	3	2	1	....	3	Brière: Du traitement chirurgical des goitres parenchymateux. Lausanne, 1871. (Cases 10, 11, 12.)
Billroth	20	12	8	....	....	Billroth: Chir. Erfahr., Zürich, 1860-67.
Middeldorpf	1	1	..	....	....	Lebert: Krankh. d. Schilddrüse.
Schuh	4	4	..	....	....	Wien. med. Wochenschr., 1859, 60.
Lücke	9	8	1	2 (cured)	7 (1 death)	Lücke: Chir. Klinik in Bern, Brière, *l. c.*, Cases 1-9.
Greene	3	3	..	3	....	Amer. Journ. Med. Sci., Jan., 1871.
Watson	6	5	1	6 (1 death)	....	Edinb. Med. Journ., 1873, p. 252; Brit. Med. Journ., 1875, Sept. 25.
Kocher	13	11	2	2 (cured)	....	Methode d. Exstirpatio Strumae nebst Bericht über 13 Fälle. D. Zeitschr. f. Chir., Bd. iv.
Kappeler	5	5	..	....	....	Bericht aus dem Spital Münsterlingen, 1874.
Sick	1	1	..	....	1 (cured)	Württemb. med. Correspondbl., 1867, No. 25.
Hofmockl	2	1	1	....	2 (1 death)	Wiener med. Presse, 1869, No. 2, 3, u. 4.
Blackman	1	1	..	....	1	Amer. Journ. Med. Sci., 1870, Jan.
Hopmann	1	1	..	1	....	D. Zeitschr. f. Chir., 1872, Bd. ii.
Holmes	1	..	1	....	1	Amer. Journ. Med. Sci., Jan., 1873.
Billroth	3	2	1	....	3 (1 death)	Chir. Klinik in Wien, 1869 u. 70, p. 130.
Michel	1	1	..	1	....	This and the following cases are taken from a paper by Michel in which the cases in French literature are assembled. Gaz. hebd., 1874, No. 44 et 45.
Desault	2	1	1	....	2 (1 death)	
Dupuytren	2	0	2	1 (died)	1 (died)	
Roux	2	1	1	1 (cured)	1 (died)	
Sédillot	3	3	..	....	3	
Bégin	1	..	1	....	....	
Cabaret	1	1	..	....	....	
Blandin	1	1	..	....	....	
Brun	1	..	1	....	....	
Percy	1	..	1	....	....	
	124	88	36	17 (2 deaths)	25 (6 deaths)	

the general verdict among them at the time of Süskind's publication was decidedly against these performances which in great measure had resulted disastrously.

Süskind writes:

"At the end of the eighteenth century when the operation was celebrating in Germany its first triumphs it was emphatically condemned in France * by all the members of the influential Academy of Surgeons of Paris except Desault,† who, according to Günther and Michel (*l. c.*), is the first French surgeon to whom is accredited the excision of a struma."

Süskind, evaluating operations upon the thyroid in terms of failure and success, writes:

"Günther in the above-cited work gives 37 cases of extirpation of solid strumas which, up to the middle of this century, he found recorded. Of these 37 cases 17, nearly one-half, ran a fatal course. Gurlt in his monograph *Ueber die Cystengeschwülste des Halses* (Berlin, 1855) enumerates 10 cases of extirpation of cystic goitres, of which, as Klein has remarked in his dissertation, three should not be regarded as extirpations. There remain, accordingly, seven extirpations of cystic goitres, one with fatal result. The total number of extirpations up the year 1850 is 44; of these 18 ended fatally—mortality 40.9 per cent. Of the operations since this time (1850) there were performed

By Germans	97	extirpations with	20 deaths,
By Americans‡	7	extirpations with	3 deaths,
By Englishmen	12	extirpations with	0 deaths,
By Frenchmen	2	extirpations with	0 deaths,

accordingly a mortality of 19.4 per cent.

"Of the various operators Bruns has extirpated the greatest number of strumas:

Bruns	28,	with	6 deaths,
Billroth	20,	with	8 deaths,
Kocher	13,	with	2 deaths,
Kapeller	5,	with	0 deaths,
Chelius	5,	with	1 death,
Meeh	4,	with	0 death.

* It was also condemned in Germany, by most surgeons, even three-quarters of a century later.

† Desault (*l. c.*) operated upon two cases—in one of them successfully (*vid.* Table I, France).

‡ Süskind's figures for England, France and America are far from complete. By reference to my tables it will be seen that up to 1877 there had been in America 30 operations with five deaths; in England 39, with nine deaths; and in France 30, with 10 deaths.

"Comparing the mortality figures of the extirpations made before and after the middle of this century, we find:

"1. That the mortality from the operation in the past 25 years has decreased by one-half.

"2. That the extirpation of strumas is not only not more dangerous than other major surgical procedures, but indeed offers greater chances of success than many dangerous, but nevertheless approved operations, such as high amputation of the thigh, resection of the hipjoint, exarticulation of entire limbs, ovariotomy.

"As far as I have been able to discover, the following are the cases * of extirpation of goitre which have been published since the middle of this century:

"To begin with Werner recorded in 1853, in his dissertation written under the presidency of Professor von Bruns (*Ueber die chirurgischen Behandlung von Strumen*), a successful case operated on by Prof. Bruns, describing at the same time the customary procedure followed in the Tübingen surgical clinic, in which were employed all possible precautions against hemorrhage in this operation.

"To this case are added the following, according to date of publication:

"1859 3 cases by Schuh in Vienna (Wien. med. Wochenschrift, 1859, pp. 641 and 657).

"1860 1 case by Schuh (Wien. med. Wochenschrift, 1860, p. 145).
3 cases by Bruns in Tübingen (dissertation by Klein: *Beitrag zur chir. Behandlung der Strumen,* 1860).
1 case of extirpation, begun but not completed, is not counted.

"1861 4 cases by Mech in Brackenheim (Med. Corr.-Bl. für württemb. ärztl. Ver., 1861, Nr. 29).

"1862 1 case by Middeldorpf in Breslau (*cf.* Lebert, *Krankheiten der Schilddrüse,* p. 221).

"1867 1 case by Sick in Stuttgart (Med. Corr.-Bl. für württemb. ärztl. Ver., 1867, Nr. 25).
1 case by Gärtner in Stuttgart (Med. Corr.-Bl. für württemb. ärztl. Ver., 1867, Nr. 40).

"1868 20 cases by Billroth, at that time in Zürich (Billroth, Chir. Klinik in Zürich, 1860-67).

"1871 9 cases by Lücke, at that time in Bern (*cf.* dissertation by Brière: *Du traitement des goîtres parenchymateux et en particulier de leur extirpation,* Lausanne, 1871).
3 cases by Emmert in Bern (*ibid.*).
5 cases by Kappeler in Münsterlingen (*Chir. Beobachtungen aus dem Thurgau'schen Cantonsspital Münsterlingen,* 1865-70).

* In Germany, Switzerland and Austria.

"1874 1 case by Hopmann in Cologne (Deutsche Zeitschrift für Chirurgie, Bd. ii).
5 cases by Chelius in Dresden (*cf.* Jahresbericht der Gesellschaft für Natur- und Heilkunde in Dresden, Oct., 1873, Mai, 1874).
"1875 13 cases by Kocher, at that time in Bern (*cf.* Deutsche Zeitschrift für Chirurgie, Bd. iv).
2 cases by Gärtner in Stuttgart (Med. Corr.-Bl. für württemb. ärztl. Ver., 1875, Nr. 29).
"1876 1 case by Gärtner in Stuttgart (Med. Corr.-Bl. für württemb. ärztl. Ver., 1876, Nr. 3).

"In addition to the 70 cases in the German literature published since the middle of this century, 23 other cases of goitre extirpations should be added. These patients were operated on by Professor von Bruns between 1861 and 1876 in the Tübingen surgical clinic. I propose to assemble these cases, together with the remaining cases of goitre extirpation made since the middle of this century (as far as I have been able to find accurate description in the literature available to me) in a tabulated review, and then to run over them for the results of the operation (mortality, dangers and indications), and describe in more detail the operative technique, especially that customarily employed at the Bruns clinic.

"In closing I shall add some especially instructive clinical histories from the Tübingen clinic.

"Upon the whole it appears that the good results obtained in late years by good operative methods only now entitle this operation to assume the place of honor in surgery which was earlier altogether forfeited on account of mishaps caused by imperfect technique.* "

I shall leave unconsidered the attempts, continued in some countries until after 1890, to reduce the size of goitres by the use of the setaceum, wick, hair seton, cannula, incision, through drainage; by the injection of iodine, tincture of chloride of iron, turpentine, etc.; by caustics and by the actual cautery; by subcutaneous and, indeed, extra-cutaneous ligature en masse of thyroid tumors or prominent goitrous nodules; by débridement, subcutane Zerreissung (Billroth), morcellement, évidement (Kocher), etc.; and shall confine myself to the story of operations performed with the scalpel.

In our tables of operations performed in France, Italy, Great Britain and the United States up to 1883, the year when the operation may be considered to have become essentially perfected in Switzerland, Germany and Austria, there are included a number of the earlier and more

* Süskind had in mind merely the technique of operating, the art of controlling hemorrhage—not the antiseptic technique.

important ligations of arteries. Counting these, the score of each of the four great nations is about 50 (France, 53; Italy, 53; Great Britain, 49; United States, 45). Most of these operations were relatively minor ones—resections of conspicuous portions of the gland, enucleations of more or less circumscribed nodules or cysts or new growths, transfixion ligations and écrasement of pedicles, division of isthmus, etc. There were few lobectomies, either single or double, and few surgeons who had the experience of more than one case. By 1883 the operation performed by Desault in 1791 had not been improved upon in France, and in America. Nathan R. Smith, in 1835,[322] Marshall in 1852[233] and Maury in 1871[228] had set fine examples which deserve to be brought to the attention of the medical profession of our country.

England made no operative contributions of importance, but Scotland could congratulate herself upon the work of Patrick Heron Watson (1874),[355] who was the only surgeon, except Bottini, of the four great nations, France, Italy, Great Britain and America, to perform more than three lobectomies and to devise a method regarded at the time as worthy of adoption. But Watson's method was crude as compared with the procedure of some surgeons of half a century earlier (Desault, Hedenus) or with the method of Victor von Bruns, practised by him in 1859 and thereafter.

Warren Greene erroneously thought himself and is quite universally believed to be the pioneer in this field in America. He was a courageous and probably dexterous operator, but his method, to be described later, was not commendable.

Given this outline, we may proceed to consider in greater detail the operative work set forth in our tables of the four countries, France, Italy, Great Britain and America.

FRANCE (TABLE I)

Michel. *De l'extirpation complète de la glande thyroïde dans les cas de goîtres suffocants, cystiques ou parenchymateux. (Opération suivie de succès.)* Gaz. hebd. de méd. et de chir., Paris, 1873, s. 2, t. x, pp. 699 and 718.

Michel gives an inventory of the cases operated upon in France to the time of his publication (1873). His comments upon these cases and his references to the animated discussions participated in by Vel-

peau, Sédillot and others make interesting reading for the surgeon who cares to trace the story. He collected 14 operations and writes:

"We count in France up to this moment 14 operations—mine makes the 15th *—including in this list extirpations partial as well as complete. Desault, 2; Dupuytren, 2; Roux, 2; Sédillot, 3; Bégin, 1; Cabaret, 1; Michel, 1. Adding the case operated by Blandin, that seen by Brun and that seen by Percy, one obtains a total of 15. Of these 15 cases there were seven recoveries (Desault, 1; Roux, 1; Cabaret, 1; Sédillot, 3; Michel, 1) and eight deaths (Desault, 1; Roux, 1; Dupuytren, 2; Blandin, 1; Bégin, 1; Brun, 1; Rullier, 1). Among the fatalities two succumbed to hemorrhage at the hand of the surgeon (cited by Rullier and Brun); in three the loss of blood was so great that the surgeon was compelled to interrupt the operation (Desault, Dupuytren, Bégin); the sixth (Dupuytren) died 36 hours after the operation; the seventh (Roux) after 56 hours. I have been unable to find the cause of death in Blandin's case."

Michel's conclusions: "1. The total extirpation of the thyroid gland should retake its rank as an operative procedure; it enjoys in France an unmerited discredit.

"2. It is expressly indicated when the life of the patient is menaced, notwithstanding the employment of all the means at the disposal of science.

"3. Partial excision of the thyroid gland appears to be at least as grave as the complete extirpation."

Michel (Table I, No. 27), after having successfully performed an excision of both lobes and isthmus in a methodical but sanguinary manner, abandoned the cutting operation and substituted for it a timid procedure which thereafter bore his name. It consisted of isolation, puncture and cauterization—"dissection-cauterization"—(Table I, Nos. 28, 29, 30).

Pierre-Joseph Desault. (No. 1.) *Observation sur l'extirpation d'une partie considérable de la glande thyroïde.* Reported by Giraud. Jour. de chirurgie, Paris, 1792, t. iii, p. 3.

Desault isolated and ligated the superior and inferior thyroid arteries before cutting them, and was, I am quite sure, the first † to dissect the firmly adherent gland from the trachea. Von Bruns, Lücke, Billroth, Kocher and surgeons of all countries up to about 1874 found it necessary to ligate the tumor en masse when it was firmly bound to the trachea; Kocher[189] states that when the tumor is bound

* We have added 12 cases to Michel's list; hence in our table Michel's first operation appears as the 27th instead of the 15th.

† Dupuytren was the second.

to the trachea over a considerable area by unstretchable adhesions "*ligation in parts being impossible,** one must have recourse to the ligature *in toto* and cut off the tumor with a knife, leaving a stump behind."

The tumor which Desault removed was probably an adenoma. When, in the course of its growth, it had become cystic, he incised it and treated it with caustics. As a consequence of the treatment and resultant infection the tumor, and, possibly, remains of the thyroid lobe also, had become indurated.

It is quite probable that the thyroid lobe had been absorbed more or less completely by the pressure of the adenoma. When this is the case the operation of hemistrumectomy is simplified and the danger of injury to the recurrent nerve is, I believe, lessened. With the atrophy of the thyroid tissue, due to the pressure exercised by the growing adenoma, a new capsule develops. This capsule may contain all that remains of the original thyroid lobe, although usually normal glandular tissue is found at the upper pole. Adenomata may be deeply buried in the thyroid, surrounded everywhere by normal or even occasionally, as in Graves' disease, by hyperplastic glandular tissue. The capsule of an adenoma may, therefore, consist solely of connective tissue or almost altogether of thyroid gland.

Many a surgeon, on enucleation of an adenoma, has believed, undoubtedly, that he had performed a lobectomy, inasmuch as no vestige of the thyroid gland remained at the conclusion of the operation. He may, however, merely have enucleated an adenoma from its transformed, transfigured capsule, and nevertheless have thought or found it necessary to ligate both thyroid arteries.

It is impossible to decide from Giraud's description of Desault's operation whether or not there were remnants of normal thyroid tissue in the part removed. In any event, the operation was a remarkable one for his time.

There are cases, but these are not common, in which no trace of the the thyroid lobe remains to suggest that the adenoma had originally been embedded in glandular tissue. The tumor in these cases is delivered more easily at operation than a thyroid lobe would be, and is enclosed in an extrinsic capsule thicker than that which ordinarily envelopes the gland. But the blood supply is quite different and less abundant.

* Italics mine (W. S. H.)

"In 1784, Jacqueline Hyons, then 20 years of age, experienced a very sharp pain in the anterior and middle part of her neck, following a violent movement of the head. Although this pain was but momentary, there remained afterwards slight restriction of movement; but three months later there appeared to the right of the trachea a small, hard, indolent tumor, without fever and without change in the color of the skin. Over it were felt lifting pulsations which showed that it was situated over a large artery; in fact, its base rested on the ordinary course of the common carotid.

"The patient, who was not at all incommoded by the tumor, paid no attention to it until June, 1788. At that time the tumor measured 1 inch in diameter, and thenceforth its progress became as rapid as it had previously been slow. Internal and external remedies had no effect upon the progress of the tumor; there was always manifest a fluctuation in the centre. On making an incision at this point there issued a yellowish serosity. Three months after this operation, which was absolutely fruitless, caustic was applied several times, also without result. At last the patient, having suffered in vain for a long time, presented herself at the Hôtel Dieu in Paris, on May 20, 1791.

"At this period the tumor was 2 inches in diameter; it was round, very hard, adherent to the right side and centre of the trachea, and pressed outwards the sterno-mastoid muscle. Besides being lifted up distinctly by each pulsation of the arteries, as has already been noted, it followed the movements of deglutition, and interfered a little with the passage of solid food.

"The patient, strongly desirous of being freed from this uncomfortable deformity, determined on the spot to undergo extirpation of the tumor, which was suggested to her as the sole expedient; but we did not conceal from her either the dangers, the length of the operation or the pain which were inseparable from the procedure. M. Desault performed this operation in the amphitheatre, after having for several days prepared this woman by general remedies.

"The patient was put on her back, inclined a little to the left side, the head and neck elevated more than the rest of the body. The surgeon made a longitudinal incision over the centre of the tumor extending it a finger's breadth above and a finger's breadth below it, in order to facilitate the carrying out of the operation. With this first incision he penetrated to the gland, dividing the skin, the cutaneous muscle and some fibres of the sterno-hyoid and thyroid muscles. Then, while an assistant drew to the left the internal border of the incision, in order to immobilize the tumor, he separated it from the sterno-mastoid muscle. In cutting the cellular tissue surrounding these parts he divided two small arteries, which he immediately ligated while they were lifted up by means of a dissecting forceps. Then, after having disengaged the external side of the tumor, the internal side was likewise freed by drawing the tumor outwards with a hook in order to facilitate its separation from the anterior part and from the side of the

trachea. In the course of this dissection the branches of the thyroid arteries were successively ligated as they were cut. Then the assistant who held the hook drew the gland inward and forward, and at the same time the operator completed its dissection exteriorly, above and below. This phase of the dissection was most minute and difficult. It was necessary to sponge continually the small quantity of blood which still oozed and prevented one from recognizing clearly the tissues. This it was which made it necessary to cut only a little at a time and to identify with the finger, before each cut of the bistouri, the part which was about to be incised. Dissecting with these precautions, the superior and inferior thyroid arteries were exposed without wounding them, and were ligated with the aid of a blunt-curved needle. These arteries were divided transversely and it was found possible to detach the tumor from the trachea, to which it was firmly adherent.

"The wound resulting from this operation was almost 3 inches deep; it was bounded exteriorly by the sterno-mastoid muscle, within by the trachea and the esophagus, and behind by the common carotid artery and the eighth pair of nerves, which appeared at the bottom of the wound.

"After having washed this wound with tepid water and having absorbed all the blood which it contained, it was filled with coarse lint powdered with colophony. Square compresses held in place by loosely applied bandages formed the rest of the dressing.

"The tumor after its excision was about 5 inches in circumference. However, it did not differ at all from other scirrhous glands, unless one notes the fact that it contained a cartilaginous nucleus.

"The patient had borne the long, difficult and painful operation with uncommon fortitude. She passed the rest of the day quietly, suffering only the pains usually present in large wounds. The following night she complained of slight feeling of heat in the neck and of slight difficulty in swallowing. She was a little relieved the next day by soaking the dressing with a decoction of mallow. For a drink weak eau de chiendent seasoned with oximel was prescribed.

"The difficulty in swallowing greatly increased on the third day, although the fever was very moderate. At this period the compresses and the external lint were renewed for the first time, and the dressing was soaked as on the previous day.

"The fever ceased after the fourth day and the swallowing became less difficult. Suppuration had already begun: the following day it had detached all the lint so that the dressing could be entirely renewed. The wound was in good condition and it was dressed only with soft lint and compresses soaked in the emollient decoction. This was continued every day.

"Nothing of note happened in the course of the treatment. The wound followed the ordinary course of wounds. It had cicatrized at the end of a month, and the patient left the hospital perfectly recovered on the 34th day after the operation."

Desault's second case (No. 3), evidently much more difficult (no details given) than the first, ended disastrously. The dissection had hardly begun when blood flowed with such appalling violence that the operator was "obliged to give up the pursuit of his object." He transfixed the incised portion of the goitre with many threads, but the patient died in spasms.

Guillaume Dupuytren. (No. 4.) *L'excision de la thyroïde.* Related by Rullier in Dict. d. sci. méd., Paris, 1817, t. xviii, p. 557.

There are many dramatic, tragic and a few even brutal performances linked in the story of operations for goitre. One of the most pathetic cases is Dupuytren's first—reluctantly, conscientiously and courageously undertaken; cautiously, deliberately and admirably performed. Rullier draws the picture in stirring lines:

"Patient, female, *æt.* 28, was of a choleric and vivacious temperament; a worker in the fields, who had always enjoyed flourishing health.

"Eight years ago, following an attack of the itch which had been driven in by cold, the patient noticed a small tumor the size of a hazelnut on the anterior and middle part of her neck. From that time the tumor constantly increased in size, but its growth, slow and gradual at first, became very rapid in the course of the seventh year. Then it made enormous progress, and covered the whole front of the neck. Like the thyroid gland, of which it was only an expansion, the tumor presented three distinct lobes, one middle and two lateral; but the first alone became offensive. It fell in front of the sternum, presenting a tumor about 4 inches in diameter.

"At this period a surgeon of Paris, at the solicitation of this young woman, determined to excise the middle lobe. He succeeded in this after making a transverse incision of the teguments. No hemorrhage or other accident occurred, and the wound which resulted from this operation was healed at the end of a month.

"Meanwhile, about six months after this operation, the two lateral portions of this goitre acquired an enormous volume, the centre itself increased rapidly, and the whole formed a tumor so extensive that respiration became difficult. This difficulty in breathing increased towards evening and when the patient lay on her back. There was also difficulty in swallowing if the food was not very well masticated. Added to this marked derangement of function was such great deformity that this woman, still young and endowed by nature with a pleasant face and good figure, was distressed to be only an object of aversion and disgust to those around her.

"It was under these circumstances that the patient presented herself at the public service of the Hôtel Dieu. She wanted to be freed from the tumor, and she declared that whatever the dangers and pain

to which she might be exposed, she was determined to submit to them. Nevertheless, in spite of her resolution, she received a negative answer, and was sent away by Drs. Pelletan and Dupuytren, who told her very positively that in their judgment she should not be operated upon. In spite of this she returned a few days later in the same state of mind but received the same answer; and all the dangers to which she would be exposed by operation were depicted to her in the most vivid colors. Besides, she was advised of appropriate measures to bring about the relief of the numerous symptoms of which she complained.

"However, nothing could convince this poor girl. She returned dissatisfied and desperate. Neither fear of the pain nor of the dangers to which she was incessantly warned she would expose herself, nor the express refusals which she had already received had any influence upon her spirit, and she did not hesitate to present herself for the third time at the Hôtel Dieu. Such perseverance at last vanquished our reluctance to admit her, and she entered the hospital January 1, 1808.

"Without, then, any fixed plan as to what might be determined to do for her, the surgeons of the hospital submitted to serious and thorough consideration the question as to what might appear best to attempt in behalf of this young woman.

"The picture which she presented at that time was as follows: Over the whole extent of the anterior and lateral regions of the neck there was a tumor extending vertically from the base of the inferior maxilla to the sternum and to the clavicles, and laterally, from one maxillary angle to the other. This tumor measured 7 inches longitudinally, and a little more transversely; one saw, as is usual in the thyroid, two distinct lateral lobes, connected with each other by a middle lobe, which was less protuberant and shorter in the vertical measurement than either of the other two. In addition, all three were irregularly nodular and soft to the touch. Their mobility differed: the middle lobe was very adherent to the larynx and moved only with it, while the two lateral lobes, loosely attached to the neighboring parts, could easily be moved in all directions. The teguments played freely over the portions of the tumor covered by them.

"The jugular veins and their ramifications were greatly dilated; the superior thyroid arteries, beating forcibly, could be palpated a little above the mid-portion of the tumor. The pulsations of the common carotids were likewise readily felt, but it was necessary to seek for them behind and outside of the tumor, into which position they had been forced. The tumor itself had never become painful, but it hindered respiration to a very appreciable degree, interfered with deglutition, and under many circumstances, notably during strong emotion, it became a cause of obstruction to the circulation of the brain; at such time the patient's face for some instants would be deep red and she would be sensible of dazzling and vertigo. Otherwise all her functions were normal.

"Such was this affection, to which one could not give too serious attention; the progress which it had made for some time past, and was making each day, the imminent danger of suffocation to which it subjected the patient, did not admit of doubt that there would soon be a fatal issue. But when, on the other hand, one considered the location, the size and the relations of this tumor, one could not contemplate without well-founded fears the hazardous operation by which one might radically deliver the patient from this tumor. Nevertheless, the dangers overbalanced too much the advantages which one might expect from the operation, and it was determined to do nothing; but at that time a sombre despair took possession of the unhappy patient, her profound melancholy increased, and she resolved to let herself die of inanition. Indeed, she refused food of any kind. The menstrual flow which took place at that time, was suppressed, and soon thereafter a condition of violent spasm, extreme suffocation and convulsive movements came to augment the torment and the horror of the situation.

"This paramount circumstance put an end to our indecision; the patient would certainly perish, and there was some hope that she might be saved by operation. Operation was promised her, and calm returned to her spirit.

"The good health, the vigor, the youth of this girl, her extreme desire to be operated upon, and, moreover, the great mobility of the tumor, the laxity of its connection with the teguments, and, in short, the knowledge of what had been accomplished with impunity for a part of the tumor gave M. Dupuytren ground for the hope which determined him at last to risk the hazards of this operation.

"Observe how the operation, at which we assisted, was performed in the presence of M. Pelletan, of many surgeons of Paris, and of an immense gathering of students.

"The teguments of the anterior and middle part of the neck were elevated in such a manner as to form of them a transverse fold of great size. This fold was incised perpendicularly from over its centre to its base; the incision was then enlarged by carrying it upwards to the symphysis of the chin, and below to the superior border of the sternum. The left edge of the incision was detached by breaking up the cellular adhesions which connected it with the corresponding portion of the tumor, then the dissection was continued on the same side by lifting up the teguments and separating them from the tumor. Thus was reached the left part of the tumor. One encountered along this course two sets of veins, one of which was adherent to the tumor, and the other of which was subcutaneous. The greater part of these veins was avoided, and as to those which one was obliged to divide, not one was cut until two ligatures had been thrown round it: one on the side towards the heart, and the other on the side towards the tumor. Meanwhile, having reached the left side and behind this part, four thyroid arteries were encountered, all of which appeared considerably dilated. They were easily recognized, and in ligating them the

same precautions were observed as in the case of the veins; that is to say, that after having previously exposed them, two ligatures were passed around each, and they were cut in the space between these two ligatures.

"Here, as throughout the operation, *one was careful to place the first ligature on the side corresponding to the brain, in order to avoid prolongation of the pain which, without this precaution, would follow the application of the second ligature.** The same care was taken in the dissection, so that almost never were the arteries opened before being ligated, and always in a manner equally secure, whatever their size.

"One thus succeeded in detaching the left lobe of the tumor, without other accident to the patient than the pain inevitable in a dissection too careful not to become at the same time a little long. Soon afterwards the right part of the tumor was encountered, and it was separated from its surroundings with the same precautions and with equal success. During this stage of the operation we encountered no intimate adhesions which had to be destroyed; the fingers and the back of the bistouri sufficed almost always. It was easy also to avoid the internal jugular veins, the common carotid arteries and the pneumogastric nerves. Twenty times one perceived these parts, but they were always pushed away, and in this manner put, without trouble, out of danger.

"It was after this stage of the operation that M. Dupuytren saw the possibility of realizing the hope which he had conceived of removing the whole of the disease. In order to achieve this end the two lateral lobes of the tumor, which had just been successively isolated, were brought out again and through the skin incision; they were held in place by elevating them and carrying them a little forward, in order to stretch, in this way, the middle part of the tumor which adhered intimately to the larynx and to the windpipe; one succeeded in this manner in the dissection of this part, but it was done only by carrying the instrument down to the very substance of the gland, extremely close, it is true, to the larynx and the trachea, so dense was the cellular tissue which established the connection of these parts. The larynx and the trachea then appeared bare. The latter presented anteriorly a very marked flattening, evidence of the prolonged compression to which it had been subjected by the tumor.

"The patient bore with astonishing courage this operation, which was long, and which called for, during a dissection made in the midst of parts which it was important to avoid, sustained and delicate attention as much on the part of the surgeon as of his aids. Never for an instant, however, did one feel fear of a hemorrhage, and the patient did not lose more than a few spoonfuls of blood; but she was several times threatened with syncope, and she was also nauseated at times.

"The wound was dressed very gently; a little lint was put at the bottom and the edges were brought together fairly well; the sheaf

* Italics mine (W. S. H.). It is interesting to find this early reference to the sensitiveness of arteries.

formed by the threads of the ligature was brought to the inferior angle of the wound.

"After the operation the face of the patient was very pale and profoundly altered; all of her vital forces were depressed; the pulse was frequent, small and concentrated; respiration was laborious and frequent, the skin quite uniformly cold; there was cardialgia and continued nausea. This unhappy woman, in a word, appeared to us to be dangerously stricken, and as if shocked by the blow itself of the operation.

"The most pressing indication to be met then appeared to be to raise again and to sustain the little strength left to the patient. Cordials were administered, but with great difficulty, because deglutition was much hampered, and one only lessened the dangers of suffocation, which appeared when the patient took a spoonful of liquid, by making her assume an almost vertical position.

"Nevertheless, from the same evening her unfavorable condition appeared to improve: to the prostration there succeeded a rather marked reaction, the pulse became frequent and high (élevé), the respiration deviated less from the normal state, color returned to the face, the skin was dry and warm, and some spoonfuls of liquid were administered without exciting nausea and vomiting. But the hopes raised by this improvement lasted a very short time, and from the fall of night the respiration became laborious, even stertorous, the pulse wretched, the skin without heat; in a word, the phenomena of the death-struggles commenced, and the patient expired the next day, 35 hours after the operation.

"Specially charged with the anatomic examination, this is what we observed in the tumor, the wound of the neck and in the remainder of the cadaver.

"The tumor which had formed the goitre was oblong, nodular, with a volume as great as that of the lungs of a young child. It presented two conoid lobes, excessively swollen. These lobes were joined together by a transverse mass, situated at their inferior and middle portion. A cellular mesh covered the whole surface of this tumor and was intimately adherent to it.

"This tumor was of a density which did not appear to be greater than that ordinarily seen in the thyroid; its weight, at the moment of extirpation, was 1202 gm., or about 2 pounds 8 ounces; its color was reddish, and its tissue was not different internally from that of the thyroid in its usual state: only the organization of this portion had become more evident by means of the considerable increase in nutrition which it had experienced. Here one perceived a multitude of small vesicular cysts, filled with a yellowish and viscous fluid; but besides, one saw here and there some points, whitish and callous, which appeared as if scirrhous. The superior and inferior thyroid arteries, as well as the thyroid veins, showed a diameter double their usual size. One may see the model in wax of this specimen in the anatomic museum of the Faculté de Médecine, where M. Dupuytren deposited it. . . . ."

Dupuytren practised the method of ligating twice and cutting between ligatures. This method has been attributed by Sick and others to Victor von Bruns. Dupuytren, in ligating arteries, placed the first ligature on the cerebral side so that patients would not twice suffer pain. I have often practised this method in local anesthesia operations, believing it to be original; but Dupuytren had the idea 100 years ago.

Dupuytren removed the entire gland in bloodless manner—"only a few spoonfuls lost." Dupuytren like Desault accomplished the feat of dissecting the isthmus from the trachea, which more than one-half a century later even the greatest German and Swiss surgeons did not believe possible.

Dupuytren waited 11 years before venturing upon a second operation (Table I, No. 6). The goitre in this case, to his disappointment, had a broad, non-pedunculated base. Hemorrhage from many veins was controlled temporarily by finger pressure, but the patient was in syncope at the end of the operation. Thus, Dupuytren who had so calmly operated upon a relatively simple case was unable to contend with a complicated one.

Roux. (No. 9.) Reported by Rufz. *De l'extirpation d'un goître.* Arch. gén. de méd., Paris, 1836, s. 2, t. x, p. 25.

A brief abstract of Roux's case (No. 9) is here given to tell of a venesection performed just after an operation from which the patient had nearly bled to death on the table. Exsanguinated patients were venesected, sometimes repeatedly, to reduce the fever of sepsis.

The patient was a young peasant, *æt.* 22, with a large goitre in the centre of the neck, presenting two definite lobes. It was irregularly round, with nodules. The symptoms from the goitre were moderately severe.

Operation, March 26, 1835: First incision in the mid-line from the hyoid bone to the sternum; second incision through the middle of the tumor from right to left. The tumor was freed partly by incision, partly by enucleation in three parts. The arteries were situated laterally, and could be for the most part ligated before being cut. Several veins were ligated. In all 40 to 47 ligatures were applied. The patient lost about "1½ pounds" of blood. The operation lasted 1 hour and 10 minutes. At 3 o'clock the lips were colorless. *The patient was bled, 6 ounces of blood being removed.** Death at 6 o'clock.

Ollier. (No. 35.) *Goître kystique ayant donné lieu à la triade du goître exophthalmique. Opération par les caustiques. Guérison de*

* Italics mine (W. S. H.).

tous les symptômes. Reported by A. Boursier. *L'intervention chirurgicale dans les tumeurs du corps thyroïde.* Thèse de Paris, 1880, Obs. ii, p. 172.

In 1877 Ollier cured by repeated incisions and cauterization a "cystic goitre," the size of a turkey's egg, which had caused pronounced symptoms of Graves' disease—pulse 160, exophthalmus, loss of flesh, etc. Two years later the patient's pulse was 80 and only a little exophthalmus remained. This case is not included in Buschan's collection (1894)[65] of 80 operations in Basedow cases.

Paul-Jules Tillaux. (Nos. 41, 47, 48.) *Sarcome du corps thyroïde ayant donné lieu à tous les symptômes du goître exophthalmique. Ablation de la tumeur par M. Tillaux. Guérison de tous les accidents.* Reported by Benard. *Contribution à l'étude du goître exophthalmique. Pathogénie. Traitement.* Thèse de Paris, 1882, Obs. ii, p. 36.

Tillaux operated upon two cases of hyperthyroidism (1880 and 1881). In both the toxic symptoms vanished.

In the second of these cases the tumor, believed on microscopic examination to be sarcoma, was circumscribed and confined to the left lobe; the right lobe and isthmus being "unaltered" were not removed. The clinical history, the operation and the thorough microscopical examination are admirably reported by Benard. This second case of Tillaux's is, I think, altogether the most interesting of the contributions of France to the surgery of the thyroid gland.

No. 47. Cazabonne, male, *æt.* 33, entered l'Hôpital Beaujean May 9, 1881. Four years previously he had noticed transitory disturbances of vision, with sometimes phenomena of cephalic congestion with headache and amblyopia. The patient also suffered with palpitation, especially after fast walking or mounting the stairs. He said that he had always had this symptom since childhood. One year previous to examination the patient noticed that his neck was enlarging. Iodine treatment had no effect. Two months after noticing the enlargement of his neck, the patient's eyes, which were naturally a little sunken, became prominent. As the exopthalmus increased the palpitation became exaggerated. Respiration also became more difficult. Attacks of suffocation occurred in the day as well as at night, and were accompanied by profuse perspiration of the head and upper part of the body. At the Beaujean, digitalis was administered. The palpitations diminished a little, but the voice became rough.

Examination, May 9, 1881: The largest part of the tumor is situated on the anterior lateral surface of the left side. There is a continuation on the right side, but much less voluminous, and appearing

to be clearly separated from the tumor by the right sternomastoid. The anterior and left portions are, on the contrary, blended, and represent in their entirety a regularly rounded tumor. The lower border completely covers the sterno-clavicular articulations and, a little, the sternal notch. The upper border runs obliquely upward and from right to left, passing 1 cm. below the Adam's apple; its left extremity reaching the angle of the jaw, about 4 cm. higher than in front on the midline. The left border reaches to the trapezius and forms a rounded and rather thick swelling. On the right the tumor stops beneath the sterno-mastoid. This portion on the right is a little soft, in contrast to the firmness of the rest of the tumor. Measurements: Vertically, 12 cm. in front, 14 cm. near the left border; 28 cm. transversely. For some years the neck measured 39 cm.: on examination it measures 47 cm. in circumference.

The skin moves easily on the tumor. On the right side the pulsations of the carotid seem weak, as if the artery were at a distance; on the left they are strong; and on palpation of the tumor there is the sensation of a veritable thrill, while it is at the same time evidently elevated by the immediately underlying vessel. Pressure on the right sterno-mastoid provokes a raucous cough with a prickling sensation in the larynx. The thyroid cartilage is thrown nearly 3 cm. to the right of the midline. The tumor does not appear to be very adherent to the larynx, but does seem to be rather solidly fixed to the surrounding muscles.

The surface of the tumor is rather regularly rounded without any prominent indentations. The consistency is firm; below and in front there is a zone where it is a little more soft, but there is no real fluctuation. One can see no movement of lifting up; palpation reveals no movement of expansion; one finds only near the left upper angle the pulsations of a superficial artery of rather large size. If the patient walks one perceives throbbing over the whole tumor, due to the exaggerated pulsations of the left carotid, which, lying immediately behind the tumor, lifts it up en masse. Auscultation reveals no true vascular bruit in the tumor, but the throbbing of the carotids is perceived over its whole extent.

Symptoms: Attacks of suffocation, due partly to compression of the trachea and partly to compression of the recurrents; rough voice, difficulty in swallowing. The two globes of the eyes are on the same plane and they reach the level of the orbital arcades. The patient estimates their projection in front at 1.5 cm. The eyelids close only with an effort; the sclera are visible around the cornea. There is continually a sense of tension in the eyes. There is diplopia when looking at objects at a distance. Movements of the eyes are easy and regular. Pupils normal.

On palpation the cardiac pulsations are rather strong, but there is no exaggerated thrill with the patient in repose; after walking, the pulsations become more frequent and the precordial impulse much

stronger. Pulse 80; much quicker if the patient takes a few steps. Auscultation of the vessels of the neck shows continuous bruit with paroxysm. Appetite is good; no diarrhea.

The patient has become irritable, flies into temper over nothing, is almost always in a state of very pronounced nervous agitation. There are frequently choreiform movements in the limbs.

Diagnosis: Exophthalmic goitre, as plain as possible.

On the left temple, the dorsal region (left side), and on the upper external part of the left arm are three small swellings about the size of a hazelnut. The patient noticed them about eight months before examination.

It was decided to operate May 18, 1881, and the patient was prepared and administration of the chloroform had begun, when he was seized with very severe attacks of dyspnea, with harsh breathing and beginning cyanosis. On this account the operation was postponed and Dr. Tillaux decided to consult the Society of Surgery.

Benard writes: "The question of anesthesia, decided in advance, so to speak, held small part in the discussion. It was decided not to use chloroform, but to have recourse simply to the administration of strong doses of chloral at the same time with subcutaneous injections of morphine.

"As to the expediency of surgical intervention, there was diversity of opinion.

"MM. Verneuil, Trélat, Duplay advised against operation, as much because of the immediate danger of the operation as of the probable hypothesis, according to M. Duplay, that the goitre might be the effect instead of a cause.

"MM. Labbé, Maurice, Perrin, Desprès, on the contrary, considering the condition of the patient who appeared doomed to certain and early death if left to himself, and being of the opinion that the surgeon should have the courage to undertake, at the risk of disagreeable eventualities, dangerous operations when they are the only chance offered to the patient, urged strongly M. Tillaux to persist in his first intention."

Operation, May 21, 1881: The operation was begun at 9.30 a. m., about one hour after administration of morphine and chloral. U-shaped incision, with the opening above. The two lateral incisions were parallel with the anterior border of the sterno-mastoids. The horizontal incision, over the inferior third of the tumor, joined the others in rounding very slightly and giving to the flap an almost rectangular form. The right branch corresponded exactly to the right border of the tumor; the transverse incision was made next (both with the bistouri); for the left incision scissors were used and the teguments were divided from below upward. Here the hemorrhage was almost insignificant and was easily controlled with forceps.

After dissecting the cutaneous flap with the fingers for 8 or 10 cm., he cut the sterno-hyoids and omo-hyoids at the transverse incision.

Now was seen the greater part of the tumor surrounded by the capsule. The operator proposed to disengage first the inferior border of the tumor by using on it from below upward a 'mouvement de bascule' and to end on each side by ligature of the thyroid vessels. With the fingers bent he commenced the enucleation. But hardly had he freed the inferior border when the capsule tore and the pressure brought forth numerous fragments of a friable, granular mass, of grayish-white color, without any cohesion. This suddenly diminished the size of the tumor; then as much with the fingers as with the spatula he set himself to dissecting the remains of the capsule, having care to cut, at the same time, between two ligatures all the frena of vascular appearance which he encountered.

New difficulties presented themselves when it was necessary to attack the left extremity of the capsule, which reached deeply beneath and behind the sterno-mastoid. It was necessary above all to avoid the common carotid and the jugular vein which adhered firmly to the capsule. An assistant retroverted the cul-de-sac of this capsule, which was then completely detached with the spatula from the vessels. The rather firm adhesions to the upper part of the trachea were seized with a T-forceps and divided. Now the capsule adhered only to tissue of glandular appearance, representing the isthmus of the thyroid, the right lobe of which did not seem to be altered.

This species of pedicle was cut after being ligated. Then the extirpation of the tumor was complete, but below, behind the sternum, there was a deep cul-de-sac filled with débris.

"Having removed this, one was able to estimate the depth of the cul-de-sac which ran towards the mediastinum; with each expiration was seen the trunk of the left innominate vein, which was of enormous size and filled up the whole space. Above, one saw the trachea thrown to the left and considerably flattened transversely. Its right lateral face was hidden by the corresponding lobe of the thyroid body and had not been uncovered; the left face, on the contrary, running almost directly from in front backward, was completely denuded and separated from the vasculo-nervous bundle by a rather large space into which reached a prolongation of the tumor.

"At the bottom of this space the whole anterior surface of the esophagus was seen, which was immediately in connection with the tumor; but the recurrent nerve had not been exposed."

All this part of the operation was effected in half an hour; but the wound was the site of hemorrhage which was controlled by means of a large number of ligatures, taking one hour.

When hemostasis was complete the wound was sutured and a drain placed in the lower part of the wound. Lister dressing; the patient was carried to a specially prepared carbolized room.

"From the first cut of the knife to the end of the dressing a 'pulvérisateur' enveloped the patient in carbolized vapors. The ligatures were of catgut. The Lister method was, in a word, scrupulously observed."

Post operation, May 22, 1881: Since yesterday the patient has not suffered. He breathes easily. Dressing changed. May 25, 1881: Cough tires patient. Deglutition and respiration easy. Tension of the eyes diminishes more and more, and the patient says that the skin of his lids seems too long. Exophthalmus still rather pronounced. Palpitations have ceased. Temperature between 39° and 40°. May 28, 1881: Diminution of exophthalmus is apparent to any one. The wound continues to be satisfactory. Sutures removed. Healing *p. p.* At this point the recovery was complicated by an attack of erysipelas. June 20: From this date recovery from erysipelas.

July 8, 1881: Patient discharged. Exophthalmus has completely disappeared, but the patient is extremely thin and weak. There is trouble in the lungs. "It is probable that this organ (lungs) is the seat of generalized cancer, from which the patient will soon succumb." The patient died July 27, 1881.

Histological examination of the tumor: "It is easily determined that it belongs to the genus sarcoma but it presents diverse varieties of this kind of tumor.

"At certain points the tissue consists solely of fusiform cells, without appreciable intercellular substance, arranged in bundles which, grouped, present themselves as cut sometimes transversely, sometimes longitudinally (sarcome fascicule).

"At other points true connective tissue fibres and trabeculæ are seen between the cellular fasciculi (fibro-sarcome). Finally, one sees at these fibro-sarcomatous points a homogeneous, faintly tinted and, in places, slightly granular intercellular substance imbedding the cells of certain bundles.

"The fusiform cells remain in relation with each other by prolongations more or less numerous. In a word, veritable mucous tissue is formed, not at all an extraordinary fact in a fibro-sarcoma, this tumor belonging to the same class as the myxoma; *i. e.*, to the tumors derived from connective tissue.

"The vessels are not very numerous; for the most part they present a simple wall which, in the sarcomatous points, is not clearly distinct from the surrounding tissue.

". . . . fibro-sarcoma, having become 'sarcome fasciculé' at certain points, and presenting myxomatous transformation in other regions much less extensive."

How is this case to be interpreted? That the patient was suffering from hyperthyroidism and that after removal of the tumor all the toxic symptoms, including the exophthalmus disappeared, there seems to be no doubt. The tumor was a circumscribed one of the left lobe. The right lobe and isthmus were, according to Tillaux, macroscopically normal. Could the new growth have been a sarcoma, as Tillaux supposed, and as the careful histologic examination by an accomplished

pathologist seemed to indicate? Is it conceivable that a mesodermic tumor could, per se, be responsible for the syndrome of Graves' disease? Had the removal of the tumor not been followed by disappearance of the symptoms we might have surmised that the remaining right lobe and isthmus were hyperplastic and not, as Tillaux believed, normal. We are forced to the conclusion that the tumor must have been epithelial, either an adenoma or carcinoma, and not sarcomatous. An adenoma may, we know, cause severe thyroid intoxication, and Tillaux's description of the macroscopic appearance of the material eventrated, in the course of the operation, from within the capsule would not exclude this variety of tumor—nor, indeed, would the metastases to the temple, arm and lung necessarily exclude it. But a carcinoma of the thyroid might bear a closer resemblance, histologically, to sarcoma than would an adenoma.

Professor Kocher called my attention to the fact that Professor Langhans, his life-long friend in Bern, who, probably, studied malignant tumors of the thyroid more zealously than any one, had finally concluded that certain malignant tumors of this gland, which for many years he had considered sarcomata (indeed spindle-celled sarcomata), were undoubtedly carcinomata. If Langhans was for a time so deceived, surely others may well have been. But it would not altogether clarify the situation to assume that Tillaux's tumor was a carcinoma, for carcinomata of the thyroid have rarely been accompanied by the symptoms of hyperthyroidism, and then only in a very mild form. Adenomata, on the other hand, may produce the complete picture of Graves' disease, even in serious form. We may assume, therefore, that the degree of anaplasia in carcinoma is not only greater than in adenoma, but that in adenoma the cells function, at least for a time, overactively. This has been convincingly shown by Goetsch [132, 133] in his illuminating studies of the mitochondria in the cells of adenomata of the thyroid.

Is it not conceivable that the tumor, if an adenoma, may in parts have become carcinomatous and thus have given rise to the metastases, while sufficient hyperactive adenomatous tissue remained to cause the toxic symptoms; or that the whole tumor was of an unusual adenocarcinomatous variety capable of producing in pronounced form the picture of Graves' disease?

Tillaux operated upon a third case (No. 48). All of his patients recovered from the operation; although in each instance considerable

blood was lost and in none were the thyroid arteries tied as a preliminary step. In all he practised a rectangular U-shaped incision. The transverse or collar incision, for the popularization of which Kocher deserves credit, had already been employed by Boeckel (1880).[35] Oblique or vertical incisions, often with supplementary cuts, were employed by all the French surgeons up to 1880.

Of the 53 cases tabulated for France, in 15 the patients died (28.5 per cent); but, excluding the relatively minor operations, the fatalities for the 12 total excisions plus the four operations which had to be abandoned and two operations for cancer were 12—a mortality of 66.6 per cent. The cause of death was hemorrhage in seven cases, sepsis in three, hemorrhage and sepsis in one, asphyxia in one, shock in one, unknown in two. No operative procedure was devised in France up to 1883 which definitely advanced the art of operating for goitre. Her surgeons were still far from being able properly to deal with the blood vessels.

ITALY (TABLE II)

In reviewing the contributions of a nation to the solution of an important operative problem one naturally looks for the names of the eminent surgeons, and usually to find that they are well represented, particularly so before the days of high specialization in surgery. Inasmuch as for the excision of a goitre the first and great difficulty was the control of hemorrhage we might hope for greatest assistance from those who had particularly interested themselves in the ligation of arteries, in the surgery of the blood vessels. In the case of Italy we are not disappointed.

Those of us who are familiar with Luigi Porta's great classic on *Delle alterazioni patologiche delle arterie per la legatura e la torsione,* Milano, 1845, may have premised that in considering the various procedures which might be employed to bring about a reduction in the size of a goitre he would first test, as he did, the effect of ligation of the thyroid arteries. After ligating one superior thyroid artery in two cases without effect, he ligated, simultaneously, both of the superior arteries in his third case (Table II, Nos. 2, 3, 4) and noted appreciable, but only temporary, reduction in the size of the goitre. Now he concluded that in the future the inferior thyroid artery should be tied, marvelling that it had occurred to no one to do this. He writes:

"Ligature of the arteries with the object of producing atrophy of tumors of the thyroid gland is a procedure really rational and destined

to succeed; but with this object in view one must ligate both the arteries of the same side, the superior and inferior of the side corresponding to the tumor. . . . . which operation (the ligation of the inferior thyroid artery) is, without doubt, more hazardous and serious than the ligature of the superior thyroid artery, but the dangers are not such as to deter a skillful surgeon; although I have had the operation in mind, I have not attempted it because no patient suitable for the undertaking has been presented to me."

Porta soon had the opportunity to test the feasibility of his proposition.

In July, 1850, a girl, aged 17, entered the clinic. There was a goitre on the left side of the neck, the size of a mandarin, which she had had from childhood, and which had grown rapidly during the two previous years.

The superior thyroid artery could be distinctly seen pulsating at the summit of the circumscribed tumor, but there was no trace of the inferior artery. The right lobe was not altered. It was decided to ligate the superior and inferior thyroid arteries on the affected side.

Operation, July 28, 1850: Longitudinal incision 4 finger-breadths in length between the sterno-mastoid and the sterno-thyroid muscles. As the ligation of the inferior thyroid artery was the most difficult part of the operation, it was decided to ligate this artery first. This was done through the inferior angle of the incision, dissecting with the index finger the cellular tissue towards the back and a little below the base of the tumor. The pulsations of the artery were clearly felt between the trunk of the common carotid and the trachea. Guided by the index finger placed on the thyroid artery, the operator succeeded in passing beneath it a curved Lawrence needle. The eye of the needle being brought out through the incision, an assistant threaded it with a little thread of red silk * which was thrown twice around the artery. Having accomplished this first ligature, the superior thyroid artery was carefully ligated without great difficulty; it ran obliquely from the external carotid to the summit of the tumor.

The operation lasted about three-quarters of an hour, most of the time being spent in ligating the inferior artery. Inasmuch as this, he says, is difficult in any case, and since it was a new operation for which the author had got the idea from studies on the cadaver, he "stayed his hand" and proceeded with great circumspection in cutting the parts and in the search for the vessel. In a footnote the author states that he lost a quarter of an hour in looking for the inferior thyroid artery behind the posterior-inferior part of the tumor, where

* Porta had a fondness for red silk, using it for ligating arteries in his experiments on animals.

it would naturally be located. He finally lifted out the lower extremity of the lobe, and found the inferior thyroid beneath it to the left of the trachea, between this and the carotid. He thinks that in another attempt he would achieve his object with greater ease and promptness.

This is probably the first case of ligature of both the superior and inferior thyroid arteries. The operation, in Porta's opinion, proved two things: that the obliteration of the two arteries of the tumor may produce radical effect, and that the two arteries of the other side are not capable of maintaining the proper amount of blood.

Porta performed 11 operations for goitre; the first in 1835; the last in 1850. Five were merely ligations of one or two thyroid arteries; the remainder were small operations—incisions or enucleations of very small tumors. In one instance he ligated the internal carotid artery (No. 5), mistaking it for the inferior thyroid; the error was discovered at autopsy. He was the first to ligate the inferior thyroid artery (No. 13). The most important and the greatest number of operations for Italy were performed by Bottini, who like Porta occupied the chair of surgery in Pavia. Bottini operated upon 18 goitres; Porta, as I have said, upon 11. Thus in Pavia 29 of Italy's 53 operations for goitre were performed; indeed, the surgery of goitre in Italy up to 1883 may be said to have begun and ended and centred in Pavia. Most of Bottini's operations were of considerable magnitude, six of them being more or less complete excisions of the thyroid gland. His first operation, in 1868, was regarded, probably erroneously, as a total removal; his second operation, also believed to be a total one, was not performed until 10 years later; then, in five years, he operated 16 times.

The period from 1878 to 1883 was one of great activity in this field in Germany, Austria and Switzerland—for Billroth, for Kocher and indeed for most surgeons in all surgical fields and in all countries. For Listerism was being introduced—eagerly adopted in German-speaking lands, very tardily in England and the United States. It was not until about 1890, 23 years after Lister's first papers on the use of carbolic acid, and 14 years after his visit to America, that the value of antiseptic surgery was generally recognized in the United States. From 1876 to 1889 the contributions to antiseptic and aseptic technique were made chiefly by the German-speaking nations; since 1889 they have come quite exclusively from America. Bottini observed "strict antiseptic precautions" in 1879 or perhaps 1878 (*vid.* No. 20); for

France the first mention in my tables of a Lister dressing is made by Monod, 1880 (No. 38); for Great Britain, by McLeod, in 1880 (No. 40) and by Purcell, in 1880 (No. 41). In the accounts of the operations in America there is nothing to indicate that antiseptic precautions were taken in a single instance. It is remarkable that Bottini, notwithstanding his great experience in operating upon goitres—an experience greater than that of any surgeon of the four countries—should not have hit upon the idea of ligating the thyroid arteries as a measure preliminary to the extirpation of the gland. The preliminary ligation was made only once in our series for Italy—by Berruti (No. 39), who removed the whole gland "by the method of Billroth."

The incisions, except in one instance, were longitudinal, or obliquely so. Ruggi (No. 44) employed a semilunar flap—approximately a collar incision.

Bottini's mortality was 16.6 per cent (3 in 18); for Italy it was 13.2 per cent (7 in 53). The fatalities were distributed as follows: Porta, 1 (No. 5); Bottini, 3 (Nos. 28, 50, 51); Colomiatti, 1 (No. 32); Fiorani, 1 (No. 34); Novarro, 1 (No. 37). There were no deaths from primary hemorrhage—one from secondary. Sepsis was the cause of death in three cases, and in a fourth was undoubtedly responsible for the fatal secondary hemorrhage. One patient died of pneumonia and one from suffocation caused by an unremoved and undiscovered post-tracheal lobule of the thyroid.

GREAT BRITAIN AND IRELAND (TABLE III)

Benjamin Gooch. (Nos. 1 and 2.) *Of bronchoceles. Medical and chirurgical observations,* London, 1776, p. 134 (being an appendix to *A practical treatise on wounds and other chirurgical subjects,* 1767).

These first cases for England are essentially the first for the world, if we may exclude cases 1 and 2 of Günther's abstracts. Gooch protested against operation in both cases. Bell [19] and Langenbeck [305] erroneously state that he either operated or intended to operate. Günther believes that he assisted at one of the operations. Gooch's quaint account of these earliest operations (1776) is entertaining and well worth repeating:

"I have had my opinion asked in a great number of tumors of this kind, and cannot recollect an instance of their endangering life, even when enlarged to a very great size.

"It is said, that in some parts of this kingdom, there are persons who undertake to cure this disease; and some years ago I had a letter upon this subject from a surgeon of character at Coventry, written in a very modest and sensible manner, wherein he acquainted me he had sometimes succeeded. But, for my own part, I must ingenuously confess, the various methods I have tried to disperse these swellings, even in a recent state and moderate size, have been defeated; * and I never durst venture to attempt the cure by excision, on account of the vicinity of the large blood vessels.

"I was once indeed prevailed upon to be present at such an operation, where the tumor was of a very large size, and the patient's blood in a thin, depauperated state.

"Before I went the operation was resolved upon, in a numerous consultation, and all I could do was to shew my fears and apprehensions of what would probably attend it, declaring, that were it a patient of mine I would not attempt it.

"The surgeon was a good and intrepid operator; but before he had half finished the operation, there was such an effusion of blood, as obliged him to desist and turn his whole attention to restraining the hemorrhage, or, in the opinion of all present, the patient would have sunk and died under his hands. She died in less than a week and, I was informed, the blood was never totally stopt. The unhappy event naturally brought the reputation of all the surgeons concerned in question.

"I remember another case of this kind, in which my opinion was asked jointly with that of an excellent surgeon in the country, my particular friend,† and the operation was performed against our judgment by one of the ablest surgeons and most dexterous operators in London, which was very near ending in a fatal hemorrhage. The young lady's life was preserved only by having a succession of persons to keep constant pressure upon the bleeding vessels day and night for nearly a week with their fingers upon proper compresses, after the operator had been repeatedly disappointed in the use of the needle and ligature, etc., as his pupil assured me who attended this case.

"I may here add a third similar case, wherein I was consulted, in which the surgeon concerned discovered an earnest desire to attempt extirpation; but I as earnestly urged the arguments I have assigned, which dissuaded him from so dangerous an operation.

* "I have talked with many eminent hospital surgeons upon this subject, and they express themselves in the same manner, who have the best opportunities of improving our art, and making useful discoveries."

† "Mr. Cooper, late of Bungay in Suffolk."

"This disease is very frequent in Swisserland, and in the neighborhood of the Alps, which made Juvenal say, 'Quis tumidum guttur miratur in Alpibus.'" *

Sir William Blizard. (No. 3, reported by Burns.) was the first to ligate a thyroid artery (1811) for the cure of goitre. Death from hemorrhage due to sepsis.

Key and H. Earle. (Nos. 5 and 6.) The ligations of Key and Earle are noteworthy because both patients had symptoms of the disease described 12 years later by Graves. Key's patient died on the second day, probably from hyperthyroidism.

Green (No. 7) is usually credited with the first excision of a goitre in Great Britain. He believed that he had removed the right lobe, but from his vague description of the operation one questions if he knew what he had done. The patient died about two weeks after operation, probably from infection.

Robert Liston. (Nos. 8, 10, 11, 12, 13, 14.) The dexterous Liston was evidently helpless when confronted with a goitre.

Edward Hamilton (1865) (No. 17) was surprised to find how easily both lobes could be freed. He transfixed the "pedicle" (the part adherent to the trachea—the isthmus). There was great loss of blood, but the patient recovered.

Alfred Poland (No. 20) creditably enucleated (1870) an adenoma.

Timothy Holmes. (No. 23.) *A case in which a large bronchocele was removed, with fatal result.* Amer. Jour. Med. Sci., Phila., 1873, n. s. vol. lxv, p. 17.

Timothy Holmes extirpated (1872) with care and skill a great cyst which hung below the patient's waist. His case is erroneously attributed by Süskind to America. Dr. Holmes writes:

"I have read with extreme interest the article on the removal of bronchocele published in the American Journal of the Medical Sciences for January, 1871, by Dr. Greene of Portland, Maine. It happens that I had been led to a conclusion similar to that of Dr. Greene as to the occasional justifiableness of such operations and had had occasion to perform the operation before meeting with his excellent paper. My case, although its issue was fatal, was one which to my

* "I have been told by gentlemen who have been in Swisserland, that this tumor in the throat, called 'goutière,' is far from being there looked upon as a personal deformity."

mind showed that such operations are not impracticable and that recovery may be reasonably anticipated in a certain proportion of them."

Woman, *æt.* 65. Enlarged thyroid for more than 40 years. The tumor gradually increasing in size, finally burst and discharged, her friends said, half a pailful. Suppuration of the enormous cyst followed. Greatly reduced in strength and when death seemed inevitable the patient consulted Dr. Holmes, who finally agreed to operate.

The tumor hung below the patient's waist. "On the right side the innominate artery could be felt extending as high as the lower edge of the tumor, and giving off its two branches; the subclavian lying over the pedicle for some distance" (*sic*).

Operation, June 19, 1872: "I did not adopt the plan of operation proposed by Dr. Greene, of endeavoring to enucleate the tumor without regard to the hemorrhage so produced. In fact, the enormous size of the mass rendered such a plan too dangerous, especially in her enfeebled state. The tumor was surrounded by appropriate incisions around its lower part; flaps were carefully dissected off it, sufficient to cover the vast surface which would be exposed; all large vessels that could be seen were divided between ligatures, and any that spirted were tied at once, and in this way we got down to the base of the tumor. Having dissected the soft parts away from the base of the large cyst to a sufficient extent, I encircled the pedicle with the chain of an écraseur so as to check the hemorrhage, while with an amputating knife I cut away the mass. This left behind a portion of the cyst. After the divided vessels had been secured, the écraseur was removed, and the remains of the cyst partly dissected off, and partly surrounded with ligatures. The operation lasted about an hour; the patient remained quiet under the influence of chloroform the whole time, and did not suffer at all from dyspnea, except when an attempt was made to pass the chain of the écraseur fairly below the tumor, instead of around its lower end. This attempt completely closed the trachea and stopped the breathing entirely. It was this intimate connection between the deep part of the cyst and the windpipe which obliged us to leave a part of the cyst wall behind; but I carried double ligatures round every accessible part of it—partly to command the hemorrhage, and partly to insure the separation of all the secreting surface. The patient lost very little blood, and her pulse was as good after the operation as before. She passed a comfortable night after the operation, and was able without difficulty to swallow milk and other liquids. Early next morning hemorrhage set in from the upper part of the wound, and before it could be stopped a considerable quantity of blood was lost; in the afternoon erysipelatous redness began to appear over the throat, the pulse became rapidly weaker, unconsciousness supervened, and she died on the following morning, having survived the operation about 39 hours. No post-mortem examination was made.

"The tumor, when removed, weighed a little over 7 pounds. It consisted almost entirely of the single large cyst, the walls of which were

of considerable thickness, containing here and there nodules of calcareous matter, and a few small secondary cysts."

James Syme (No. 25, reported by Watson). James Syme, Scotland's famous surgeon, seems to have been almost as greatly embarrassed (1874) as Liston in the presence of the blood vessels of a goitre.

Patrick Heron Watson. (Nos. 27, 28, 29, 30, 31, 32, 33, 34.) *Excision of the thyroid gland.* Edinburgh Med. Jour., 1874, vol. xix, p. 252.

Watson's triumphs undoubtedly entitle him to the dominant position in the field of goitre surgery, not only for Great Britain, but also for France, Italy and America. Warren Greene excepted, he is the only surgeon of these countries who devised a special method of operating and practised it systematically and with success. His method served him well in the first seven cases, but in the eighth, having wounded "a large vein lying posteriorly in the groove between the trachea and esophagus," and being unable to control the hemorrhage, he accidentally opened the trachea in his haste to detach the tumor from it. The patient died from aspiration of blood. Watson's method almost guaranteed difficulties for the surgeon—difficulties which even those who approved of it would hardly have been able to cope with. He was not master of the art of dealing with blood vessels, and few could have been in those days when surgeons, handicapped by example and training and without suitable equipment, had not developed a deliberate manner of operating. His first operation was in 1871. In 1874 he reported five cases, all successfully operated upon by him. He writes:

"The operation of excision of the thyroid gland has no claim of novelty to render it attractive. It has been practised previously by different surgeons, notably by the late Mr. Liston, and the ill success which attended upon the attempts to extirpate this organ, when most requiring operative interference, has served to deter most writers of the present day from recommending its adoption. Before practising this operation, I had twice assisted at operations where a partial extirpation of the hypertrophied organ was adopted. In one case under the care of the late Mr. Syme, where in a cystic goitre, after tapping and injecting the cyst, aneurismal signs manifested themselves, he laid open the pulsating sac, and failing to arrest the hemorrhage, which poured out in a rapid stream, he seized first one side of the sponge-like sac and then the other, cutting away as much of the walls as could be exposed. In this case the hemorrhage proved unrestrainable, in spite

of stuffing the cavity with sponges and stitching the margins of the incision together over them, and the patient died in our hands. In the second case, Professor Spence extirpated a tumor of the isthmus of the thyroid with complete success, but with great bleeding attending upon the division of the vascular connexion. The hemorrhage which complicated both of these cases was certainly such as to make any one timid in adopting such a proceeding."

Watson describes the second operation in greater detail than the others.

Case 2: "In her case, I operated by a long linear incision, which sufficed to expose the upper and lower margins of the tumor. After dividing the skin and cellular tissue, and opening the fascia over the interval between the sterno-hyoid and thyroid muscles, carefully avoiding the fascial sheath of the thyroid gland, I carried my forefinger and thumb over the margin of the tumor at its upper and right-hand corner, and feeling that I had the vascular connexions of the tumor, with the right superior thyroid artery in my grasp, I introduced an aneurism-needle through the fascial sheath in the middle line, bringing it out again at the right side of the level of the equator of the tumor. A ligature was passed through the eye of the needle, and when the needle was withdrawn, the ligature was left in its track. This ligature was confided to an assistant, and held aside. The needle was again passed in the situation of its former emergence, guided by the finger, and then passed beneath the right inferior margin of the gland, so as to include all the right inferior thyroidal connexions. The ligature was similarly withdrawn along the track of the needle. The same process was repeated upon the left side, a ligature being carried beneath the left superior and inferior thyroidal connexions, together with their delicate investing fascia. These four ligatures were then separately tied, so as to secure the vessels included within their cellular sheath as near their origins as was possible; the further separation of the tumor was effected by curved scissors.* As the right superior thyroidal attachments were divided, the ligature came away in the hands of the assistant to whose care it had been confided. A gush of blood took place, but was at once stanched with a sponge thrust into the wound."

In three of Watson's patients (Nos. 28, 29 and 31) exophthalmus was noticed. No mention is made of other eye signs or of tachycardia, or other symptoms of Graves' disease. All of these were "cystic goitres," possibly adenomatous in origin and hence probably toxic. It is noted in one of them (No. 29) that "the anemia and exophthalmia which were present on admission markedly diminished after the operation." I recall no earlier mention of exophthalmus having been

* E. S. Cooper of San Francisco practised a similar method in 1861.

improved by thyroidectomy. It was, indeed, accidentally discovered by several (*i. e.*, Tillaux,[338] Rehn,[283] Mikulicz [349]) that Graves' disease could be cured by operation upon the thyroid.

In August, 1875, Watson [355] read a paper on *Excision of the thyroid gland* before the surgical section of the British Medical Association in Edinburgh. This paper is almost a verbatim reproduction of his earlier communication in the Edinburgh Medical Journal, 1874. I mention this because Süskind's " two successful operations performed at Chalmer's Hospital," given in his English list of 13, were undoubtedly Watson's, and counted twice; also because Watson in his second paper recounts a fatal case, as follows:

" In this fatal case, the tumor, of a very large size, was adherent to the trachea. After preliminary application of ligatures and the division of the vascular attachments upon the right and left sides had been effected, on turning the tumor to one side, a large vein, lying posteriorly in the groove between the trachea and the esophagus, was unfortunately wounded. The pressure of the sponge applied to arrest its bleeding, together with the drag upon the trachea when the tumor was turned to one side, interrupting the respiration, led me to attempt to separate the attachments of the tumor from the trachea rapidly by means of the knife in a deep wound, from which bleeding was still going on. The thin and soft posterior wall of the trachea thus turned outwards was unfortunately wounded; and, before relief could be afforded by opening the trachea and introducing a tracheotomy tube below the level of the tumor, so much blood had been sucked into the air-passages as to determine a fatal result in the course of the evening."

Spence, McLeod Whitehead. (Nos. 39, 40, 43.) Three cases operated upon by Watson's method. Spence modified the method by dividing the isthmus and removing the lobes separately. This is probably the first instance in Great Britain in which this procedure was practised. The patient, who quite possibly had Graves' disease, died within 24 hours.

The remainder of the operations tabulated for Great Britain are relatively minor ones, although for the day they were major undertakings in that they represented the best efforts of the best operators.

UNITED STATES AND CANADA (TABLE IV)

We have found reports of 45 operations for goitre in America up to 1883. There were five deaths, one of these (Maury, No. 21) occurring from pneumonia three weeks after operation and when the wound was almost healed and the patient convalescent. Including this case the

mortality, therefore, was only 11 per cent; excluding it, 9 per cent. There was only one death from hemorrhage (Cooper, No. 8) unless possibly another in the case of Valentine Mott (No. 2), which Gross reports in a single line. But the hemorrhage in two of Greene's cases was "fearful." In Nathan R. Smith's case sepsis was the cause of death; the huge pendulous tumor was ulcerated and sloughing at its dependent portion. Of the remaining two fatalities, one (Maury, No. 21) was, as just stated, due to pneumonia incurred three weeks after operation; the other (Hamilton, No. 26) followed a tracheotomy and was also probably due to pneumonia. One would naturally expect to find the greatest mortality in the cases of excision of both lobes; but in the 10 more or less complete thyroidectomies there was not a death. The cases of Nathan R. Smith (No. 4), E. S. Cooper (No. 8), Warren W. Greene (Nos. 13, 18, 19), E. L. Marshall (No. 14), F. F. Maury (Nos. 20 and 21) and C. E. Fenwick (No. 23) deserve especial consideration.

Nathan R. Smith. (No. 4.) *Extirpation of the thyroid gland.* North American Arch. of Med. and Sur. Science, Baltimore, 1835, vol. ii, p. 309.

The patient, *æt.* about 40, was a Mrs. Wells of Prince George's County, Maryland. The thyroid enlargement was noticed about 1815; this is the only date given in the paper. The tumor "occupied the whole space between the os hyoides above, and the sternum below, and by its weight it had assumed something of a pendulous form, falling over the margin of the sternum. The general configuration of the tumor, in short, was that of a common goitre, and when the integuments were entire it presented the varicose veins usually conspicuous in that disease.

"Some months before the case fell under my observation, the skin covering its most prominent and dependent point had ulcerated, and all the means which had been employed to effect the cicatrization of the sore had failed. There had now issued from this breach of the integuments, a dark, fungous excrescence, represented in the drawing, and presenting a strong resemblance to the fungus hematoides. From this excrescence there issued a sanious and offensive discharge, and occasionally slight hemorrhage had occurred.

"On carefully examining the relations of the tumor (together with Professor Geddings, whose advice I requested) we became satisfied that it was one of the thyroid gland, the right lobe of the organ being chiefly concerned. We could distinctly feel and see the sterno-hyoid and sterno-thyroid muscles passing like tense ribbands vertically over the tumor. The margins of the sterno-mastoid muscles,

on each side, were raised and spread upon the sides of the tumor. More obscurely, the situations of the omo-hyoid muscles were also discerned.

"The superior thyroid artery of the right side was distinctly felt and seen, descending superficially, in a tortuous course, obliquely upon the lateral and anterior portion of the tumor. The left thyroid artery could be obscurely felt. On handling the tumor for the purpose of determining its deep attachments, we could readily cause it to glide beneath the muscles of the neck and upon the trachea and larynx; but, owing to its magnitude, it was impossible to determine the nature of all its relations with the deeply seated parts on which it rested. We satisfactorily ascertained, however, that the great vessels of the neck were not involved in, or adherent to, the tumor.

"On carefully weighing all the circumstances of the case, it was manifest that there was no rational ground for hope that any course of palliative treatment would arrest the progress of the disease or effect the cicatrization of the ulcer. The propriety of attempting the complete extirpation of the tumor was now considered. We arrived at the conclusion that the operation would be attended with extreme difficulty and great peril to the patient, but, as a dernier resort, we regarded it as justifiable in case the individual and her friend, on being made acquainted with the circumstances of the case, should desire the attempt to be made. In a few hours I was informed that our patient had firmly resolved to place herself wholly in our hands, and cheerfully to incur the hazard of any course we might see fit to pursue.

"On the ——— of ——— I performed the operation, with the assistance of Professor Geddings, Dr. Whitridge, Dr. Thomas, of Elk Ridge, and several medical pupils. I commenced the operation by making, in the integuments, an elliptical incision, the length of which corresponded with that of the neck. Its central and broadest portion included the ulcerated and fungous portion of the tumor. I then commenced my dissection around the body of the tumor on the right side, it being my desire to expose and secure as quickly as possible the thyroid artery. This I soon effected, though in consequence of its exceedingly tortuous course, I wounded it and secured it at more than one point.

"I now proceeded to raise the border of the sterno-mastoid muscle, and lay it back from the tumor. In doing this I encountered (that which does not usually exist) the anterior jugular vein, the vessel being somewhat withdrawn from its close proximity to the border of the sterno-mastoid muscle by the fascia involving it, which was tensely drawn over the anterior part of the tumor. As the muscle was retracted with some force, such tension of the parts was necessarily produced, as compressed the vein and emptied it of its blood. The wounding of the vessel, under these circumstances, was therefore scarcely to be avoided. Blood soon flowed freely from the wounded

vessel, its flow being hurried by the struggling, and deep, strong breathing of the patient. I was perfectly aware of the great danger of the inhalation of air into the vein, and the fatal consequences which might be expected to result from its reaching the heart in any considerable quantity. I, therefore, while making efforts to secure the vessel with the ligature, was careful to grasp the border of the sterno-mastoid muscle, including the lower portion of the vein, with the finger and thumb. The vessel was secured with the armed needle; but notwithstanding my utmost care, I twice distinctly heard the gurgitation of a small bubble of air, as it entered the vein, at the moment of a strong and deep inspiration of the patient. For a moment I desisted from the use of the knife, and looked in the face of my patient to observe the effects of the ingress of air into the veins. Happily the quantity was not sufficient to produce any obvious effect, and I proceeded with the operation.

"Having now passed through the strata of blood vessels which pertain to the muscles and to the border of the thyroid gland, I proceeded in my dissection with much greater facility. On the left side I effected it with much more ease than on the right; but here also, on the division of the thyroid veins, I distinctly heard the gurgitation of air. To guard against its repetition during the remainder of the operation, I was careful, whenever I divided any fascicules which might be supposed to contain veins, to grasp it firmly with the finger and thumb below the incision, and if blood flowed from the upper portion, to secure the lower with the ligature. I should have remarked that I found it necessary to divide the tendon of the omohyoid muscle on each side.

"As I progressed with the dissection of the tumor from the deep-seated parts, I found it necessary to proceed with extreme caution. The sheath of the great vessels on each side lay in immediate contact with the tumor and, indeed, was to some extent incorporated with it. I also found that the fascia covering the thyroid and cricoid cartilages was thickened and adherent to the tumor. Its separation from these connections was the most tedious and difficult part of the operation. The separation of the tumor from the parts immediately above the border of the sternum, where I was prepared to expect great difficulty and danger, was effected with infinitely more ease than I had anticipated. The vessels in this region appeared, by the traction of the tumor, to have been elongated, and to some extent obliterated. The thyroid artery, particularly on the right side, presented the appearance of a long, loose, hard cord, pulsated but feebly, and was secured without any difficulty, being drawn out with the tumor. On the left side I secured nothing but branches. The veins of this region were neither numerous nor large, they having no doubt been diminished by the pressure of the parts upon the sternum.

"At length I succeeded in effecting the complete removal of the tumor. There was now left a frightful chasm in the throat, the

larynx being dissected quite bare, especially on the right side, and the trachea exposed as low as the border of the sternum. The great vessels on each side were also seen throbbing in their sheaths. The recurrent laryngeal nerve was distinctly seen on the right. The last point from which I detached the tumor was a portion of the thickened tissue covering the thyroid cartilage, and its attachment here was very firm. When I had severed it, two or three minute arteries sprung, one of which I immediately secured; but as the hemorrhage then appeared to cease, I did not take up the others.

"The operation was necessarily painful and protracted; its execution occupying an hour; the patient, however, endured her sufferings with wonderful fortitude, and at no time did there take place any alarming sinking of the powers of life. Twice or thrice, at her desire, I had delayed a few minutes to allow her a moment of comparative repose, but neither then, nor after the operation, did there appear to have been inflicted any serious shock.

"In the morning, on visiting Mrs. Wells, I was alarmed at finding the dressings bathed in blood which was still flowing from the wound, and evidently of the arterial hue. I immediately cut the stitches, opened the wound, and turned out a mass of coagulated blood, and found the bleeding to have occurred from a minute artery seated where the last attachment of the tumor had been cut away. I secured the vessel with the ligature, and as there was a disposition to hemorrage from minute vessels, I applied to the part a small compress of lint dusted with alum powder.

"On the fifth day, however, there occurred a severe rigor, followed by fever, sonorous and embarrassed breathing, cough and irritability of the stomach. It passed off with a sweating stage, precisely as a paroxysm of intermittent fever. The wound, which had suppurated kindly, now began to exhibit a flabby appearance, and to discharge an unhealthy secretion.

"It is not necessary that I should relate the subsequent progress of the case; suffice it to say, that the rigors recurred every day, notwithstanding our endeavors to parry them, and that the patient expired on the 13th day. The chills were evidently of malarious origin, and my patient undoubtedly came to me predisposed to intermittent fever. To this, in part, I think I may with propriety ascribe the fatal result."

When we consider that the patients were unanesthetized and that the surgeon until many years after Nathan R. Smith's day was without artery forceps, and had to rely chiefly on aneurism-needles, hooks and the pressure of fingers or sponges for the control of hemorrhage we must concede that the most difficult task of the present-day surgeon is hardly more creditable than this operation by Smith upon the thyroid gland in 1835. The control of hemorrhage has always been, as it is today, the chief concern of the operator. Now the

surgeon is provided with literally hundreds of artery clamps and the patient being anesthetized there is no need for haste; the operator, unperturbed by the cries or struggles of the patient or the fear of hemorrhage, proceeds calmly and surely from one step of a well-perfected method to the next.

Nathan R. Smith had quite surely never seen an operation performed upon the thyroid gland, and it is not unlikely that he had never heard of such an operation, although he concludes his paper with the sentence, "Instances in which the operation has been successfully accomplished are no doubt fresh in the minds of the readers."

My admiration for Dr. Smith, Baltimore's "Emperor," has been greatly increased since reading his modest and lucid report of a case, the importance of which he could hardly have comprehended. I have seen no reference to this case in the literature except in the Index Catalogue of the Surgeon General's Library. It is surprising that Samuel D. Gross did not know of this chef d'œuvre of Nathan R. Smith.*

E. S. Cooper. (No. 8.) *Operation for the removal of bronchocele. Death of the patient.* Cinc. Lancet and Obs., 1860, vol. iii, p. 15.

"Important surgical operations proving successful, should generally be reported to the medical world, but those terminating fatally should always have the widest range of publicity among the profession.

"In consequence of the great fatality attendant upon operations for the removal of bronchocele, the practice is now generally abandoned. The extent and importance of the tissues involved, when the tumor is large, rendering the operation dangerous in the highest degree, is sufficient reason why it should not generally be resorted to, except in extreme cases.

"There are those, however, where the disease is rapidly growing, and from the hardness of the enlargement and its pressure upon the windpipe suffocation must inevitably result at no distant day, in which an attempt at removal may be made. Such is the one I am about to relate.

"Case: Mrs. M., *æt.* 24 years, consulted me on the 3d of October, 1859, in consequence of an enlargement on the left side of the neck, extending from the clavicle to near the chin. It was twice the size of a man's fist, and had been over four years attaining that size, and during the preceding year increased very rapidly. It pressed heavily upon the trachea, which was considerably flattened. Pulsa-

* Both were professors at Jefferson Medical College—Smith, professor of anatomy from 1825 to 1827; Gross, professor of surgery 29 years later.

tion of the left carotid artery could be distinctly heard on applying the ear over it, while the sounds of expiration and inspiration could be as clearly heard over it as by applying the ear to the chest. There was distinct pulsation nearly all over the tumor. In the act of swallowing, it arose and fell with the motion of the trachea, and was much more firmly fixed over the region of the trachea than over the outer part of the neck.

"I was convinced that I had made a true diagnosis before operating, and that it was not aneurism, but bronchocele, though some of my medical friends thought it might be the former.

"I have been consulted in regard to many cases of bronchocele, but I never saw any one presenting so fearful a prospect for the use of the knife, and from the lights before me, conferred by the experience of others, I never would have decided upon removing this disease by the knife; and notwithstanding the certain prospect of a fatal termination of the case at an early day, I would have either sent the patient away hopeless, or pursued a temporizing course, as had been my custom in other cases, but for having decided to try the écraseur, by which I concluded I might succeed in removing it without the dangers of fatal hemorrhage, so often attendant upon the use of the knife.

"For the purpose of applying the instrument, I made the crucial incision over the tumor, and reflected the flaps of integument down its sides until I thought one-half of it was exposed, after which I passed needles armed with ligatures deeply into its substance in six different places, to be strongly drawn upon by my assistants, thinking thereby to force the chain round the tumor to its under side. It was soon ascertained, however, that the chain would slip forwards in spite of the ligatures. I therefore made a further dissection, so as to expose the entire anterior half for the purpose of inserting the ligatures as before.

"About this time the procedure was arrested by a collapse of the patient, apparently from the effects of the chloroform.

"The patient became pulseless, and for some seconds respiration appeared entirely suspended, but by the use of brandy and other stimulants, with electricity, she had reaction, when the écraseur was again applied; but the use of the instrument was still found to be impracticable, in consequence of the firm attachments of the tumor to the trachea, in consequence of which the chain would have broken down and carried part of it away, instead of separating it from the tumor. I therefore laid aside the écraseur, and took up the scalpel to dissect the tumor away from the trachea; but in effecting this I found it necessary to ligate the primitive carotid artery a little above where that vessel crosses the lower part of the trachea.

"This I think was the most difficult dissection I ever did. The extreme low point on the neck at which I was compelled to ligate this vessel in order to place it out of the reach of being subsequently wounded, together with the density of the abnormal adhesions among

the different structures, rendering their separation with the scalpel exceedingly difficult, while the use of that instrument was hazardous in the extreme, were the causes of this dissection being so difficult.

"The carotid artery being tied, I concluded to extirpate the tumor by the knife, which was accomplished in 1 hour and 20 minutes from the time the operation was commenced, with the loss of a comparatively small amount of blood.

"The internal jugular vein was not wounded, but the anterior and external jugulars were both ligated above and below, as also the superior and inferior thyroid and some other enlarged veins. There were but four arteries besides the carotid and inferior thyroid ligated.

"The tumor being removed, the flaps of integument were brought together by sutures, and were formed sufficiently large to cover the exposed surface. Adhesive straps were put upon the wound, and a piece of lint wetted with an evaporating lotion placed over it, when the dressing was completed.

"The patient revived considerably, and appeared to be doing tolerably well for two hours, but perfect reaction did not take place, and she died in five hours from the time the operation was concluded.

"The great length of time occupied in this operation was owing to the care with which part of the dissections had to be made, the delay occasioned by the sinking of the patient at one time from the chloroform, and the time occupied in the efforts to use the écraseur."

E. S. Cooper. (No. 9.) *Cutting away of a bronchocele without hemorrhage, with a case. Remarks.* Med. and Sur. Reporter, Philadelphia, 1862, vol. viii, p. 38.

"Operation, March 27, 1861: Mrs. P., *æt.* 27, applied to me with a small tumor situated at the isthmus of the thyroid body, of 10 months' standing. It was the size of a hen's egg, and moved up and down in the act of swallowing. It was unattended with pain and had increased in size but slowly. Its growth was, however, constantly perceptible to the patient, and caused her great mental anxiety.

"Being convinced that all methods in use among surgeons will fail to give that freedom from hemorrhage, at the same time certainty of success, with avoidance of suffering to patients, and of deformity after cicatrization, which the nature of the disease and surrounding tissues reasonably warrant, I have for some time been gradually departing from the usual practice.

"My first method was dissecting away the tissues covering the tumor, then passing ligatures through its lower as well as its upper parts so as to include the thyroid arteries.* After this, transfixing the enlargement at different points and in different directions by

* Thus he anticipated Patrick Watson, who, 13 years later, described the very similar method which he and his followers practised with marked success.

needles armed with ligatures of great strength, in case of large tumors using a sort of nevus needle made, on purpose, with a long, piercing extremity, sufficiently long to transfix readily a tumor 4 inches in diameter.

"Many double ligatures being thus passed through the tumor and their ends tied tightly together, it is at once reduced to one-fourth or one-sixth of its natural size. Sloughing occurs in these cases without secondary hemorrhage. But as cases operated upon in this way have been often published with their results, I shall not dwell upon it now, but proceed to my *second* method.

"This consists in exposing the tumor as before and transfixing it above and below, throwing ligatures around the substance as described before and cutting it away close to the ligatures. This was done in the case mentioned without more hemorrhage than results from the simplest operations. Should the wound bleed too much in any case, I would whip-stitch the entire cut surface.

"In this case every symptom was favorable from the commencement, and on the 21st day after the operation the patient left for her home in the country, almost recovered, and with very little deformity from cicatrization, which was almost complete.

"Remarks: Although the method of treatment adopted in the above case is applicable to those of bronchocele generally, still the surgeon will now and then meet with the vascular or *aneurismatic* bronchocele in which the excessive hemorrhage resulting from every stroke of the scalpel will be such that he is finally compelled to abandon the operation; but these cases are extremely rare, and the surgeon should not in any case be too much alarmed at a sudden gush of blood, as that will often occur in cases where the hemorrhage is perfectly controllable by occasionally whip-stitching the bleeding surface.

"I repeat here, substantially, remarks made in the publication of other similar cases elsewhere, which is done so that any who read this report, but may not have read the others, will understand it.

"Surgical writers often state that the method of ligating the thyroid arteries frequently results in secondary hemorrhage. This I have never seen in any case. Is it because of ligating the arteries in the midst of a mass of other tissue and at the same time strangulating every part of the tumor, as mentioned in the first method, or removing the unnatural growth close to the ligature, as in the second, thus causing a consolidation of the tissues around the arteries, that prevents the secondary hemorrhage as chronicled in the books?

"And at this point I am reminded of a question which has often arisen in my mind, as to whether the ordinary method of ligating blood vessels by isolating them completely first, is not based upon erroneous principles. Whether the necessity of drawing the ligature sufficiently tight to cut the inner coats of the artery, is not favorable to the production of secondary hemorrhage, by inducing the too early sloughing of the ligature; and whether it would not be better in

all cases to include such surrounding tissue as would admit of it, is also a question.

"Of course a nerve could not be included in the ligature; but muscle, fascia, cellular tissue, and even the veins might be included. The veins which have heretofore been supposed to be particularly disposed to phlebitis when wounded are found to be not more so than the arteries, unless the wound of the vein causes the arrest of the undecarbonized blood in its way back to the heart. But when that occurs, it becomes dangerous, because the accumulation of venous blood acts as a foreign substance and source of great irritation.

"I am now constantly in the habit of sewing up the ends of arteries, even of considerable size, in a mass of other tissue, when the vessel is either hard to isolate and tie, or in that exposed situation which would leave the ligature liable to be disturbed by the sponge or other cause during the subsequent steps of the operation.

"I do not believe that it is at all necessary to draw a ligature sufficiently tight, when applied to any artery, to cut the inner coat, as is supposed. Pressure, by which the hemorrhage will be arrested, would produce a change of action in the parts sufficient for the effusion of fibrin, by which the vessel would become filled.

"We have innumerable examples of pressure causing the effusion of coagulable lymph. Why should a ligature be drawn more tightly upon an artery than simply to arrest the hemorrhage? It appears to me that if there is any reason why this should be done, it is to keep the ligature from slipping, which may be readily effected by including some of the surrounding tissues. In natural amputations of the extremities, the arteries are hermetically sealed by the process of nature, and a firm clot is formed in the vessels without the aid of ligature. Who knows whether the inner coats of the arteries are cut by the ligatures even when drawn tightly? If not, it is very obvious that a very tight ligature would favor the too early division of the vessels without there being any just cause for the risk."

William Warren Greene. (No. 13.) *Successful removal of a large bronchocele.* Med. Record, New York, 1866-67, vol. i, p. 441.

"It is well understood by the members of the profession that extirpation of an enlarged thyroid gland is one of the most fearful operations ever undertaken by the surgeon. While there is always great danger from shock, secondary hemorrhage, inflammation of the cervical vessels and of the esophagus and respiratory organs, *the* danger which overshadows all others, hanging like a thunderbolt over patient and operator, is terrible and uncontrollable hemorrhage.

". . . . such surgeons as the Coopers, the Bells, Ferguson, Velpeau and others have been obliged to abandon operation.

"I have quite carefully examined the literature of this subject, and so far as I can learn, *all* bronchoceles that were ever successfully re-

moved (and there are very few) were small. I am very confident that none were as large as that which I shall describe." *

Woman, *æt.* 45. The tumor had been growing for 26 years. Pressure symptoms were so great that attempts to swallow or talk caused "terrible spasms of dyspnea." She was unable to lie down. Suffered from headaches and giddiness and could not stoop without losing consciousness.

Operation, dates not given (Aug. (?), 1866 (?)): Vertical incision. "Fearful hemorrhage" from veins on exposing the tumor. "I now rapidly separated the areolar attachments, and in a few seconds was at the pedicle, which I found containing three large arteries whose pulsations were very distinct, and which were my guides for dividing the pedicle into three parts, which I also accomplished with the fingers. I immediately tied each third with a ligature composed of 18 strands of saddler's silk, *saturated* with wax and *loosely twisted.* As I drew the last cord all hemorrhage instantly ceased. The pedicle was carefully divided close to the goitre, and it removed. During the dissection I found at one point the tumor quite firmly adherent to the sheath of the vessels; and while separating it, a gush of venous blood indicated the rupture of a large vessel. The finger of an assistant controlled it until the ablation of the bronchocele, when examination proved the internal jugular to be wounded. This was tied with a ligature of three strands of silk loosely twisted; no other vessels needed interference. The entire operation occupied 22 minutes."

The patient was restored to perfect health. The weight of the tumor was one pound and nine ounces. The paper is illustrated with interesting woodcuts showing the patient before and after the operation.

William Warren Greene. (Nos. 18 and 19.) *Three cases of bronchocele successfully removed.* Amer. Jour. Med. Sci., Philadelphia, 1871, n. s., vol. lxi, p. 80.

No. 18: Woman, *æt.* 40. Tumor, the size of a small orange, in the right lobe caused great difficulty in swallowing.

Operation, Oct. 25, 1869: The tumor was removed by enucleation. Simple operation except for adhesions to esophagus. Recovery.

No. 19: Woman, *æt.* 35. The tumor had been growing slowly for 20 years. Headache, vertigo, dysphagia and an alarming degree of dyspnea were complained of when she consulted Dr. Greene in August, 1869. "To the fingers, as to the eye, the tumor pulsated everywhere." At one point there was a distinct thrill and bruit. "So marked and peculiar was it that an eminent hospital surgeon of Buffalo had pronounced it an aneurism of the common carotid.† But it was certain

* Greene evidently knew nothing of the European literature.

† Thanks to the courtesy of Dr. Frederic Henry Gerrish of Portland, Me., who assisted at the operations in this and the previous case, I have photographs of this patient. There is nothing in the facial expression definitely to indicate Graves' disease.

that this case was more formidable than either of the others—involving both lobes, being of immense size, and more vascular than any goitre I had ever seen; and I did not believe that removal by the ordinary mode of enucleation of morbid growths, attempting to control hemorrhage step by step, was possible. I considered the chance to be a hundred to one that she would die upon the table or of secondary hemorrhage soon after."

Operation, Jan. 20, 1870: Ether. Vertical incision. "At very many points the thin coats of superficial vessels gave way, and uncontrollable oozing resulted. Still the hemorrhage was not immediately alarming until the dissection, which was carried on by the fingers, reached the calcareous portion of the tumor on the right side. Here adhesions were encountered of considerable firmness, and as they yielded to the most careful efforts I could make, the large branches, which had given the aneurismal thrill, and whose coats were extremely attenuated, burst, and immediately we had the most fearful hemorrhage, such as one who has not seen it can hardly realize. This took no one by surprise, as I had already forewarned my assistants of its probable occurrence, and in such event of the entire futility of any expedient, except the rapid completion of enucleation and seizure of the vessels at the base of either lobe. This I accomplished in a very few seconds and was enabled so to seize the pedicle with the fingers as to suppress the bleeding measurably until I could transfix it with the blunt needle, armed with double ligature made of eight strands of saddler's silk. This was carried in the median line from below upward, close upon the trachea, and either ligature tightened sufficiently by a single knot to control the hemorrhage and give time for examination. I had hoped to separate either half of the pedicle into as many parts as there were arteries, as I did in my first case. This I found impossible from the firmness of the tissue, unless I used a cutting instrument, which I did not dare to do. I, therefore, tied either half as tightly as possible, and carefully severed the tumor from its attachments. This being done, seven small arterial twigs, not connected with the growth, were tied, when all hemorrhage ceased. The wound was now kept open, only ether enough being administered to keep her quiet, and time given for glazing of the surface and reaction of the circulation. Within 10 minutes the vessels in every part of the exposed surface were throbbing violently, and in 15 minutes from the ablation of the tumor the inferior thyroid artery of the left side escaped from the ligature and spirted with great violence. In my own opinion, as in that of the attending surgeons, this vessel was equal in size to the common carotid in its normal condition. In a moment this was seized and secured; then, the entire left half of the pedicle being transfixed with a tenaculum, a new ligature of 12 strands was carried underneath both the original one surrounding the pedicle and the separate one around the inferior thyroid artery, and drawn as tightly as possible. From this time, all bleeding was arrested, and in a few minutes the wound was closed with

silver sutures, a light dry compress applied, and the patient placed in bed with a fair pulse of 100 per minute, and presenting no marked signs of collapse."

Secondary hemorrhage occurred on the tenth day. "One week before the operation she lost her voice entirely. Since the removal of the tumor she has fully recovered it."

It is interesting to note that the laryngeal nerves have rarely been paralyzed in the many cases operated upon more or less in this fashion, and that neither cachexia strumipriva nor tetany developed. Presumably a considerable amount of thyroid tissue was left behind in the écraseur ligatures en masse.

The thyroidectomies of Warren Greene deserve conspicuous mention in the history of American surgery; for this reason I have quoted at such length from the picturesque and spirited describings of this dauntless practitioner.

E. L. Marshall. (No. 14.) *Extirpation of the entire thyroid gland. Recovery.* Chicago Med. Jour., 1867, vol. xxiv, p. 97.

"In your journal for December last, I find the report of a case of removal of one-half of the thyroid gland, by Prof. Wm. Warren Greene, being the third instance (so far as my own information extends) of this operation having been successfully performed in America. Dr. Geo. McClellan, Sr., of Philadelphia, is said to have succeeded in a single instance (his being a single lobe only) and my own, performed Jan. 18, 1852, comprising the entire gland, with Dr. Greene's more recent case, of August 19, 1866; all of which patients have had good recoveries. I am unaware, at this time, of there being a single case of a fatal or unsuccessful operation in this country.

"My patient, Mr. John Mank, now residing at Bridger's Corners, Mercer Co., Ill., had consulted a number of eminent surgeons, among whom were Professors Mussey and Joseph N. McDowell, also Professor Brainard, and S. S. Cooper, of Peoria, all of whom, after an examination of the case, gave it as their opinion that an operation for removal of the gland might, eventually, become justifiable. To my own knowledge, Mr. Mank has been, from time to time, through a period of many years, subjected to vigorous treatment, with reference to absorption of the tumor, all of which had not even checked the progress of the morbid growth.

"Referring to my notes, I find that on the 12th of January, 1852, the patient had for three months been unable to lie down, and required constant watching to save him from suffocation; was subject to spasms of great dyspnea; constant headache; had twice had convulsions from attempts to lie down; was mentally despondent, declaring that he preferred death to such an existence. After making a full statement

of the hazards incidental to extirpation, it being the only resource left upon which to fall back or recommend, I left it with himself for decision. He promptly requested me to undertake the removal of the tumor. In this decision I had the happiness of having the concurrence of Drs. Adam Clandaning and A. B. Campbell, whose valuable counsel and assistance I here take the occasion to acknowledge.

"The patient, Mr. Mank, aged 40, a gentleman of high order of intelligence, and, previous to his health having been impaired by his present affliction, a man of great muscular power, possessing a high order of moral courage—such courage, indeed, as I have seldom, if ever, witnessed in any other person.

"The patient, declining the use of an anesthetic, took his position (agreeable to his own request, in an arm-chair) and I proceeded to operate by making an incision through the median line, commencing a few lines above, and completing as much below, the lower border of the tumor. This wound I transformed into a crucial incision; detached the flaps and dissected them down to their base; fleshy fibres that were not easily pushed aside were divided transversely, until the entire superficial surface of the body was exposed. I now separated the tumor from its bed, by dividing the several fasciæ on the director and tearing up the areolar tissue with the finger and handle of the scalpel, until the base of the gland was freely exposed. There was but little hemorrhage from the superficial vessels of the tumor, and none that required especial care, save a couple of small arteries that were found lying alongside the thyro-hyoid muscle, imbedded in the cellular lamella. These were ligated—they were, perhaps, branches of the lingual or maxillary arteries. The pedicle of the tumor being reached, I found each lobe to be supplied with two arteries (the superior and inferior thyroid). Each portion containing a vessel was surrounded by a heavy ligature of loosely twisted saddler's silk. The inferior arteries were now sealed without any disturbance of organic function; but on attempting to tighten the ligatures of the superior vessels, we were met by a difficulty that was well-nigh fatal to our operation. This occurred incidental, as I believe, to pressure upon a branch of the great sympathetic, the pneumo-gastric, the glosso-pharyngeal, or fibres from two, or possibly all three, of those important nerves. Be that as it may, on any attempt to ligate these vessels, the patient suffered from severe paroxysmal cough, labored breathing, and a lessening of the force of the heart's action that was truly alarming. As we could not hope to be able, under the circumstances, to find and exclude the small, thread-like fibre from the ligature, we did that which I believed to be the next best thing in the premises—to destroy the functional integrity of the nerve; this was done by tightening the cord and holding it firmly so long as the patient was able to endure and live, when it was loosened and interrupted organic functions were allowed to resume something of their normal condition. This required but a few minutes, and here was witnessed a heroism

upon the part of Mr. Mank that was truly sublime. Nothing daunted by the peril, so well understood by himself, he was always ready, after his brief rests, to request that the work of nerve-crushing might be resumed.

"After several efforts of this kind, I had the happiness of knowing that the difficulty was so far overcome as to admit of ligation, which was accordingly done, and the tumor was removed without farther trouble.

"The tumor, when examined, was found to be hard, firm, with cartilaginous deposits, and weighed 1 pound 11 ounces, avoirdupois.

"I would especially invite attention to the fact that, in the case of Mr. Mank, the only serious difficulty encountered during the operation was in the dissection of the nervous communication between the gland and nervous centres, while in Dr. Greene's case no such trouble was had, neither have I any knowledge of any such barriers to the successful execution of the operation being encountered by any other party attempting the extirpation of this gland; while all refer to the fearful hemorrhage incidental to the rupture of delicate superficial veins, spread like a network over the body. In my own case, the walls of those vessels were sufficiently firm to admit of careful dissection, without risk to their continuity."

F. F. Maury. (Nos. 20 and 21.) *Extirpation of the thyroid gland for cystic enlargement.* Photographic Review of Med. and Sur., Philadelphia, 1871-72, vol. ii, p. 17.

"During January of the present year, my colleague, Dr. Parry, of the obstetrical staff of the Philadelphia Hospital, asked my advice in reference to a tumor of the neck, in a patient then an inmate of his wards. After repeated and careful examinations, it was clearly defined to be an enlarged thyroid gland.

"The history was as follows: The woman was 23 years of age, born in Cheshire, England, and when nine years old first discovered a small swelling on the anterior part of the neck, its situation being somewhat to the right of the median line. This slowly but gradually increased up to the date of my seeing her. She then complained of but little pain, some difficulty in deglutition, and scarcely any obstruction to her respiration, save in certain positions. She manifested great desire to be rid of the tumor, though the strongest representations of the gravity of the operation were fully made and understood. It was decided to attempt the reduction of the tumor by the process of electrolysis. This was fully tested and afterwards abandoned, the result being entirely negative. In February, before extirpation was resorted to, a final effort was made to produce an impression on the morbid mass by electrical cauterization, which was effected by means of a large Bunsen's battery of 15 cells. This procedure was more effective than the former. The phenomena here evolved were of a

very interesting character. A perceptible crackling noise was audible in the tumor during the application of the needles, which were heated almost to a white heat. Great induration was developed around the negative pole, and the tumor at once began to increase in size, measuring before the operation 16 inches, and in two hours 17. Great dysphagia also followed, and excessive pain when the parts were touched or the head moved. During the day following, all the symptoms of acute inflammation were present; these, however, began to subside in a few days, leaving the patient in her former condition, save the induration around the site of the entrance of the negative pole. In April it was finally decided to resort to the knife. The patient being fully influenced by chloroform, an incision 5 inches in length was made over the most prominent part of the growth, parallel with its perpendicular diameter, and this joined by a horizontal one of sufficient extent to allow free manipulation during the operation. The firm, dense capsule of the gland was soon reached by a division of the bands of fascia overlying. It was soon seen that the thyroid arteries were greatly enlarged, more especially the right and left inferior. All these were well secured in turn, as likewise all smaller vessels. In this way *absolutely* all hemorrhage was avoided.

"The cyst was then peeled away from the trachea for the extent of 3½ inches. The sheath of the right carotid was undisturbed, but fully exposed, as also that of the left. The wound was closed, no hemorrhage followed, and the patient did well, excepting a slight attack of erysipelas, which came on three days after, and, queerly enough, involved the face and portions of the neck to the entire exclusion of the wound.

"This case is pregnant with interest, but space will not admit of its free elaboration. It must suffice to say that here the repeated use of electricity would not have availed much, as the consistency of the tumor would have resisted it entirely, or the time occupied by this mode of treatment would have compassed many months. When the capsule was opened, the structure was found to be dense, and very tenacious in character, and not apparently very vascular. The belief that this operation in many cases can be effected is confirmed by the fact that I removed, some weeks after, another very large growth of the same kind in the same manner, and with the best result, as respect hemorrhage and shock. This patient did well for 21 days, and was then seized with pneumonia and perished, after all the ligatures had become detached and the wound almost healed. The subject of this photograph was seen some days since in the enjoyment of perfect health. She has never experienced any difficulty, save slight aphonia, which has now disappeared."

H. G. Jameson (No. 3), was the first and only American on our list and the tenth in the world to tie a thyroid artery for the cure of goitre. The ligation was made in 1821, only 10 years after the opera-

tion of Sir William Blizard, who was, as I have said, the first to perform this operation. Four of Great Britain's surgeons besides Blizard attempted to cure goitre by ligation of one superior thyroid artery (Coates, 1819; Key, 1824; Earle, 1826; and Sir Benjamin Brodie, 1832). In Earle's case the opposite superior thyroid artery was tied at a second operation, a month after the first. Alquié (1854) was the only French surgeon to ligate the thyroid arteries *per se*. In Italy the first five operations for goitre were merely arterial ligations—Marzuttini, 1844, and Luigi Porta, 1835, 1846 and 1848 (2). At the autopsy of Luigi Porta's second case it was ascertained that his ligature had been placed on the internal carotid which he had mistaken for an enlarged inferior thyroid artery. In 1850 Porta ligated the inferior and superior thyroid arteries of the left side. The circumscribed goitre of the left lobe vanished, leaving no trace. No further attempts were made by Italian surgeons to cure goitre by ligation of the thyroid arteries. W. H. Welch in 1874 * (unpublished thesis) collected 32 cases of ligation of one or more thyroid arteries for the cure of goitre.

Ch. G. Lange [207] is accredited with having been the first (1707) to suggest tying the thyroid arteries in case of goitre. This is what he has written:

"Magis vero efficax esset sectio Arteriae, quae ad strumosos tumores sanguinem defert, modo vas illud prompte inveniri, & haemorrhagia statim iterum sisti posset. Veterinarii quidem hoc modo procedere dicuntur, & arteriam, quae ad strumosos tumores equorum defertur, abscindendo, efficere, ut strumae evanescant; in homine tamen haec operatio non sine periculo instituitur." †

To base a claim of priority for Lange on the evidence furnished by the above quotation would seem to require a highly developed patriotism or a carefully nurtured naïveté. Lange, apparently, did not distinguish scrofulous tumors from goitre, or if he did he had in mind the former, not the latter, when he proposed ligating or dividing

* St. John's paper [211] was founded upon this thesis of Dr. Welch.

† "But more efficacious would be the division or ligation of the artery which conveys blood to the strumous tumors, provided this vessel may be easily found and the hemorrhage forthwith checked. Veterinarians, indeed, are said to proceed in this manner and by dividing the artery which supplies the strumous tumors of horses to bring about the disappearance of the struma; in man, however, this operation will not be undertaken without peril."

"*the* artery." Furthermore, he had the impression that one artery supplied "*the strumous tumors,*" and unquestionably had not the remotest notion of the whereabouts of this hypothetical vessel. And, finally, he warns against undertaking on man this operation, the credit the devising of which he accords to the veterinarians.

Apropos of patriotism, I yield to the temptation to offer my readers extracts from an amusing controversy between von Walther and Chelius on the subject of national as well as individual priority. Philipp von Walther was the first to tie successfully the superior thyroid artery, the case of Blizard having terminated disastrously (*vid.* Table III, case No. 1).

Chelius[81] writes: "Because I credit the Englishman Blizard with the first performance of this operation (and I know of no other German author who has done so) Herr von Walther has been stirred to direct against me the following rather strong attack. It will surely be a satisfaction to my highly esteemed Herr von Walther to have the matter cleared up, inasmuch as the correct history of the operation in question is at stake.

"Herr von Walther says: 'Moreover will our dear countrymen ever cease abasing German achievements in surgery to the indisputable minimum, and creating prejudice with scholarly industry against the German discoverer whenever they can exhume from a foreign land the slightest trace of priority? Certain it is that among the English and French we have no competitors for the glory of such uprightness, probably also none to envy us. Even were it true that the ligation of the superior thyroid arteries for the cure of aneurismatic goitre is a discovery of English surgery, as a German writer relates, it still remains a fact that independent of this and simultaneously (? !) or with a trifling difference in time, the idea originated in Germany and was there successfully carried out. Untrue it is (!) that the operation was proposed by Jones. Jones speaks of the ligation of the thyroid arteries only interrogatively, as of a means to make possible the extirpation of the thyroid gland, not to cure the goitre without extirpation (? !). In regard to the time when Blizard performed his operation, there is nothing to indicate it either in the brief account by Burns nor in the equally brief notice in S. Cooper's *Surgical Dictionary,* 4th Edition. Nowhere is the date of the operation mentioned. From what source then does one know what so positively is asseverated, that Blizard undertook this operation before me? The meagre descriptions of Burns and Cooper seem indeed to prove that they and Blizard had no knowledge of my paper on goitre. But I know with certainty that this little paper was carried to England soon after its appearance. In that country, too, the *Salzburger medicinisch-chirurgische Zeitung* is read, in which some years earlier I had pub-

lished a brief report. Since, however, I do not know the date of this operation I will not quarrel about it. It would be just so much the more interesting and gratifying if indeed the idea of this undertaking had originated with him or Burns. Such a coincidence would be the more likely to kindle a favorable fore-judgment and entitle to the hope of its future establishment in the field of operative surgery.'

"The entire passage, so far as it concerns the history of the ligation of the thyroid arteries, contains nothing but untruth.

"In the second volume of my *Handbuch der Chirurgie,* p. 1160, where I ascribe the priority of the ligation of the thyroid artery to the Englishman Blizard, I have quoted from S. Cooper's *Surgical Dictionary,* London, 1813, 2d Edition, and added the German translation from Burns' *Surgical anatomy of the head and neck.* Had Herr v. Walther seen this second edition of S. Cooper in which on the dedication leaf the 4th of February, 1813, is noted, he would have been able to acquire the absolute conviction that Blizard several years earlier than he must have performed this operation. But if this interval of time should not be great enough for the pronouncement of an opinion in regard to the priority of this operation, then the original paper of Burns (Edin., 1811, p. 202) suffices to dispel any doubt of the most sceptical. These are the sources upon which I base my assertion. Inasmuch as I give reference to the second edition (1813) of Cooper, Herr von Walther should not have taken refuge in the fourth edition which appeared a long time thereafter. Concerning the date of the Blizard operation one need not harass himself so very much, since it is not a question of days or months, but of several years. . . . .

"How does v. Walther happen to make such a statement as this: 'It is untrue that the operation was proposed by Jones. Jones spoke of the ligation of the thyroid arteries only interrogatively, as of a means to make possible the extirpation of the thyroid gland.' Jones says: 'I inquire then further, cannot this procedure, stemming the circulation of the blood through the arteries, be employed with advantage in cases of bronchocele?' Neither in this nor in the appended comment of Spangenburg is to be found the remotest justification for the view that this ligation was proposed as a means for making possible the extirpation of the thyroid gland; an inference quite to the contrary is to be drawn. The entire asseveration of v. Walther I can explain to myself only in this wise, that with Jones he confounded Charles Bell, who in his *System of operative surgery* says: 'Before making the attempt to excise the thyroid gland one might propose ligating the four arteries which supply it.' This passage has no bearing upon the question of ligation of the superior thyroid arteries of which we are speaking; wherefore I did not refer to C. Bell in narrating the history of this operation. On whose side now is the untruth? After all, as a result of thorough investigation it develops that the honor for the suggestion to ligate the thyroid arteries in cases of goitre belongs to a German, to Ch. G. Lange, who already in the year 1707

speaks of it most unequivocally (*sic*). Whether this will be satisfactory or not to Englishmen is immaterial—history must not be distorted (Die Geschichte muss gerecht seyn)."

We have seen, just above, how precise were Lange's views on the subject, and it is fortunate that the Library of the Surgeon General possesses his precious tract.

GERMANY

To tabulate the numerous operations for goitre performed by German, Austrian and Swiss surgeons (395 up to 1883) in the same elaborate manner as has been done for the British, French and Americans would require too much space; I have, therefore, merely enumerated them (*vid.* Table V) and have devoted the pages to the better purpose of tracing the mental processes of the world's leading surgeons in their journey towards the goal, hoping that it may be profitable and enjoyable to my readers to learn from the lips of the men who have created and perfected the operation for goitre the story of their progress. I have told in the foregoing pages enough to indicate that so far as the art of operating is concerned nothing of real significance was contributed by any of the four countries—France, Italy, Great Britain and America; but more important than the art was the science, the contributions to which from Great Britain and America made progress in surgery possible. Prior to the introduction of anesthesia, little surgery was done in the world; and after this, when operations soon had multiplied in every land, sepsis reared its head, and finally so dominated the situation that in some countries, particularly those where operating was done on the largest scale, hospitals had to be destroyed and operations, if done at all, had to be performed in pavilions. It was the fear of hemorrhage that deterred surgeons from operating for goitre, but it was from sepsis that most of the patients of the Swiss, Austrian and German surgeons died.

From the canvass which portrays the work of the resolute men, who at the outset went to the aid of the gasping victims of goitre, the figure of Hedenus looms in my eyes perhaps largest. At the very beginning of the nineteenth century he extirpated six suffocating goitres without a death, a feat which was not repeated for three-quarters of a century.

J. A. W. Hedenus (Dresden). *Ausrottung der Schilddrüse.* Journal d. Chir. u. Augen-Heilk., Berlin, 1821, Bd. ii, p. 237.

Hedenus begins his communication thus:

"Although I have six times and successfully performed this operation, which on account of the arteries, veins and nerves is so difficult and dangerous, I will relate the story of only the most important one, namely the second, notwithstanding the fact that the third, fifth and sixth were not less significant.

"That the operation belongs to the most difficult of surgical undertakings is evident from this, that several authors maintain it is unachievable; thus Wichman says in his *Diagnostik,* 'To attempt to extirpate a goitre as one would a scrofulous gland is equivalent in German to nothing less than literally to cut off the neck.' Even the great and, for German surgery, unforgettable Professor Richter in Göttingen, who for every physician and surgeon in Germany is immortal, assured me verbally that on account of its great danger he has never performed this operation and never will."

P. 240: "Inasmuch as all of these patients operated upon by me would have died of suffocation, ... I resolved to interfere, notwithstanding the risk, and for the following reasons: In the first place, to relieve them of life-threatening danger and of sore distress; and secondly, in order to demonstrate to my students what an operator who is endowed with courage, determination, calmness, perseverance and patience, and who possesses the requisite anatomical and surgical knowledge, can accomplish with the bistouri for the good of mankind."

Abstract of Hedenus's case 2: Male, *æt.* 21. Large goitre which caused rattling in the throat.

Operation, October 8, 1800: Vertical midline incision. In liberating the tumor sufficiently to expose the superior and inferior thyroid arteries * "64 arteries were tied." The thyroid vessels were then doubly ligated and divided. The difficulties increased as the operation progressed, because always new arteries had to be ligated in the depths of the wound. Since arteries as large as the radial continued to present themselves *the pedicle of the tumor was transfixed with a double ligature and tied off.*† The goitre was then cut away without further bleeding. The operation required 1½ hours.

Stormy convalescence. Difficulty in swallowing, hoarseness, paresis of right arm, chills and high fever, delirium, extensive infection of wound, abscesses under scapula and hemorrhage from the stump on

* It seems to have been the aim of Hedenus to tie the thyroid arteries at as early a stage of the operation as possible.

† Italics mine (W. S. H.). This method of treating the so-called pedicle was followed in all countries for about 80 years. For notable exceptions see cases of Desault and Dupuytren.

the eighth day; on the 17th day severe hemorrhage from the upper angle of the wound. On the 23d day the patient was permitted to get out of bed. Ultimate recovery.

I doubt if we can realize today what it meant in the year 1800 to perform in a fairly bloodless manner and without anesthesia an operation of such magnitude.

Considering the circumstances, are not, perhaps, these operations of Hedenus for goitre performed about one and one-quarter centuries ago as great as, if not greater than, any surgical accomplishments of the present day? We have only to bear in mind the warnings against performing this operation, from one-half to three quarters of a century later, of Dieffenbach, Liston, Velpeau, Gross, Mott and many others, including surgeons even of our time, and to recall the sensation made in this country by the relatively crude operations of the courageous Warren Greene, 70 years after Hedenus, to comprehend in some measure the credit due to this surgeon.

In striking contrast to the admirable operative procedures of Hedenus are the detestable performances of Klein (1815).[184] Do the chronicles of surgical horrors record a more revolting tragedy than the one staged by Klein in the case of the deaf and dumb child? The comments of this exultant operator on his foolhardy achievement accord well with his doltish savagery.

Dr. Klein (Stuttgart). *Ueber die Ausrottung verschiedener Geschwülste, besonders jener der Ohrspeicheldrüse und der Schilddrüse. Ausschälung der Schilddrüse.* Jour. d. Chir. u. Augen-Heilk., Berlin, 1820, Bd. i, 120.

Case 1: Deaf and dumb boy, *æt.* 11 years. Delicate and very small for his age.

"Finally, in June, 1815, the child was brought to me, and I was astonished, as was everyone who saw it, at the remarkable nature of the growth. It occupied the whole of the left side of the neck extending from the ear to the third rib. Blood vessels, finger-thick, were spread over the surface of the tumor, which on account of its weight rather than from adhesions was quite immovable. At its base the transverse diameter was 6 inches, the vertical, 5; its transverse arch measured 16 inches, its longitudinal, 11½. It was very nodular, and here and there pulsation could be felt in the arteries which entered it. Since in this case no other measure was possible I decided upon extirpation in spite of the great difficulty and the manifest danger. I had to deal here with a child who could in no way be made to comprehend anything, who even while measurements of the tumor were being taken was unmanageable.

"The child was placed on a table because I dared not let him sit on the lap of an attendant, since his breathing would have caused motions interfering with operative precision. One assistant held the head, two assistants, one on each side, held the arms, and two, the hands and feet. I stood on the right side, rapidly made two oval cuts over the tumor, and on each side dissected up a flap. From the many large vessels, everywhere cut, there came, as was to be expected, a considerable quantity of blood, but always fingers enough were ready to arrest the hemorrhage. However, in the brief period, over ½ pound of blood was lost. The left lobe was quickly cut away; this could be done the more readily, inasmuch as the incisions crossed above and below. An assistant now pressed a cork firmly upon the carotid above the collar-bone. I pulled the tumor with the fingers forcibly upwards and, keeping always on the under surface, using sometimes the fingers, sometimes the knife, and sometimes its handle, separated it from the entire length of the carotid, from the whole trachea and larynx and from below upwards shelled out the right lobe. To do all this required—who would believe it?—1½ minutes. Even I would not have believed it, for the time seemed to me very long, especially when I was stripping the tumor from the carotid. But several onlookers who counted the seconds agreed as to the time elapsed.

"To our amazement, no bleeding followed; even the divided thyroid arteries did not bleed, and except for the hemorrhage from the divided superficial veins very little blood was lost during the operation. We were still more astonished to find the child lying there without a sign of life. I ordered quickly a sponge dipped in cold water to be placed on the wound and the face to be dashed with cold water; thereupon deep spasmodic breathing took place. I regarded it as a deep swoon. The boy let out a cry only when the first cut was made, at any rate no one heard any further sound, and this was excusable considering the concentration of the operation. For about three-quarters of an hour the body was rubbed and brushed and splashed, and stimulants and all the reviving means employed; during this time the heart, and occasionally also an artery, could be felt to beat feebly, but the inspirations gradually decreased in frequency, and then without the slightest convulsive movement life was extinguished.

"The necessary routine precautions to be observed in case of possible return to life were prescribed, but the child remained dead.

"Now arose the question, what could have been the cause of death? Loss of blood it certainly was not, nor was it injury to the carotid; injury to the vagus could with equal certainty be excluded, because in the first place this is not fatal and, second, it presents a different picture. Entrance of blood into the larynx either by mouth or through an injury of the same or of the windpipe it could not be, otherwise there would at least have been violent coughing and a streaming out of air. If we consider, furthermore, the short duration of the operation, the manner of death becomes more inexplicable.

"The next morning I examined the body. The edges of the wound all the way up to its upper angle could have been beautifully brought together. The carotid, the vagus, the vena jugularis were throughout their entire length covered with a thin layer of connective tissue. The sterno-cleido-mastoid, pushed far to one side, was cleanly dissected, but not injured. At the exit of the carotid from the aorta I made an incision and injected water upwards several times, but not a drop escaped from the carotid; it did, however, from the dilated thyroid arteries which had been cut off so long that their ligation would have presented no difficulties. The nervus vagus was dissected throughout its entire length and found to be nowhere injured—indeed it could not have been because the carotid was intact. Alongside of the carotid were four cervical vertebræ still covered with fascia (so deep had the tumor extended); the esophagus was bared for the same distance, and bared also were the windpipe and larynx which had been forced to one side. I slit them from below upwards through the glottis, but not a drop of blood did they contain. How difficult the enucleation must have been one can now comprehend, and one can conceive also how beautifully and rapidly the operation must have been performed.

. . . . "At any rate, the connoisseur in passing judgment upon a faultless operation is influenced not by the result but by the artistic manner of its performance; and in the present case I have for myself no reproach, but only congratulation.

. . . . "This is the first extirpation of a thyroid gland of this size which has come my way. I have never seen the operation performed; nor have I ever practised it on the dead body,* for the opportunity never presented, or else, perhaps, I did not embrace it. It would be presumptuous to make generalizations from one case, but I openly confess that I cannot understand why one stands in such awe of hemorrhage and I admit, just as freely, that I was not in the least apprehensive on this score, and that I performed this operation with absolute courage and with the consciousness that happen what might I should certainly be equal to the emergency.

. . . . "In all cases the thyroid arteries must be cut; in the first instance, the trunks; in the second, the branches. In the case of the latter, gum arabic, combined with continuous pressure against the cervical vertebræ and vigorous constriction of the basal surface, can be relied upon. In regard to the ligation of the arterial trunks as well as of all other arteries whether of skin or muscle which must necessarily be cut, I confess that I would not follow Desault or Richter among others who advise before ending the operation to tie each divided artery. The latter, in his lectures, gave this advice for all operations, even in ablations of the breast. I, too, followed him in the beginning, but soon wrote to my venerated teacher that, for various reasons, I should no longer follow his advice, and since then, too, I do so no more and find that I get along better."

* Unless, possibly, this operation was on the dead body (W. S. H.).

Case 3: Baron von T., *æt.* 22. At the age of 14 years a circumscribed hard nodule appeared in the lower part of the right thyroid lobe. Increasing in size it finally caused difficulty in swallowing and a feeling of pressure in the head. He became despondent and resigned from the army. Other forms of treatment having failed to give relief he was told that an operation of a dangerous nature alone offered hope. His misery became unendurable when he had " the frightful misfortune to shoot to death in its cradle the only child of a much-beloved brother. Thereupon, overruling all my objections he insisted upon having the operation performed. Over the inner end of the right collar-bone, under the sterno-mastoid muscle I found a hard mass the size of a dollar. This disappeared completely at times and could only be recovered by lateral rotation of the head and repeated attempts to swallow, combined with the pressure of the neck against the clavicle. If seized quickly with the fingers one could force it up to the middle of the windpipe. The patient made his will, and insisted upon having the operation performed, so I resolved to do it notwithstanding its dangers. On the 4th of April [year not given] I performed the operation, to describe which will be as difficult as was the procedure itself. My intention was to cut directly down upon the upwards dislocated nodule. This was unachievable because the patient could not endure the pressure necessary to hold the tumor in position. I drew up, therefore, a fold of skin and made through it a 4-inch incision parallel with the sterno-mastoid muscle and down to its tendon. But now the lump could not be felt; it had withdrawn itself behind the collar-bone so far that I could barely touch its upper edge. It is really difficult to understand that so many futile attempts had to be made before the tumor could be seized. Finally, after various twistings of the head and repeated efforts of the patient to swallow, I succeeded in catching it with a double hook in one of the moments when it bobbed upwards. Now swiftly I transfixed it with a needle, made a sling of the thread and in this way held the hard lump. The overlying muscles, the sterno-mastoid included, were divided. But the omo-hyoid, which happened to be pierced by the loop of thread, I cut in two, because at the moment the latter was more important for me than the former.

" Partly by means of the very useful loop of thread, partly by the hook and partly by the fingers I succeeded in pulling forward the tumor, but as I progressed I had to cut with greater caution. The deeper I went the more I had to use blunt instruments. And now whether I pulled or dissected, the patient suffered either indescribable, transitory pains in the head, or spasms of the diaphragm, or a painful, uncontrollable tendency to swallow and vomit, so that quickly I had to change the direction of the tug or of the dissection; the enucleation was thereby complicated, and the more so because the tumor now proved to be much larger than I had thought. In the course of the delivery the superior thyroid artery was cut through and spurted

smartly; but as I intended to bring the operation rapidly to a finish the hemorrhage caused me no concern. After I had freed in this manner about two-thirds of the hard mass, the consequences of the tugging on the vagus and phrenic nerves became more and more pronounced and hence on this account and also because the operation had been so prolonged and the hemorrhage so great I concluded to tie off the tumor and cut it away distal to the ligature. But as I tightened the loop and thus pressed forwards the tumor, I squeezed it entirely free from its connections: the loop glided behind the growth which almost delivered itself as I continued to draw up the knot. Now, thought I, the game is won and I can alter my plans. Accordingly, I sliced away the tumor, but at the same time cut in two the unusually dilated inferior thyroid artery, whereupon the loop of thread followed after. The hemorrhage which ensued can be imagined. To ligate was out of the question—the hole from which the bleeding came extended 2 inches below the clavicle (to this depth I could pass my index finger). Pressure could not be brought to bear, the operation had lasted a quarter of an hour, the patient's condition was bad, the sponges employed became instantly soaked through with blood and cast out. It was high time to act promptly. There remained only one thing to do—to ram a sponge the size of a fist into the hole and to keep up the pressure on it by six assistants in turn. This availed; the bleeding ceased and therewith the consternation of all of us, who believed that I had severed the carotid, so great was the hemorrhage.

"There is nothing especial to be said about the dressings and the treatment. On the second day there was considerable fever; there developed a continuous cough, producing irritation with a very disagreeable sensation in the region of the diaphragm, and associated with this a distressing shortness of breath which compelled the patient to remain in a sitting position. These symptoms were clearly referable to the irritation of the nerves of the diaphragm caused by the sponge. It was surprising that neither the swallowing nor the speech was in the least affected.

"Each day the suppuration increased, but the sponge remained fixed, nevertheless. One dared not make forcible attempts to withdraw it, and I was six hours distant. On the ninth day the sponge began to show up above the surface of the wound; by cutting away the projecting part, by gently pulling in one direction and another, by twisting it on its axis, etc., I finally succeeded in bringing out the sponge which was indescribably swollen. Only an insignificant hemorrhage, from the edges of the wound, followed its withdrawal. Without exaggeration the sponge was one-third larger than at the time of its introduction; a more precise estimate of its relative size I am unable to give because the instant it was laid aside a hunting dog devoured it. (It is of course a digression, but still sufficiently remarkable to deserve mention, that this very large sponge did the dog no harm. We never knew whether the dog disengorged the sponge or not.)

"In the third week the wound was healed and our patient is one of the happiest of men."

Victor von Bruns. Almost the entire story of progress in the surgery of the thyroid gland for the third quarter of the last century may be found in the operative work of Victor von Bruns. In 1851 he removed successfully several nodules, from the size of a hen's egg to an apple, from the isthmus and both lobes of the gland. His second operation was in 1856; the patient died of septicemia. Then each year, with few exceptions, he had either one or two cases until 1876 when he operated upon six. For 1862, 1869 and 1870 no case is recorded, but for 1864 there are three—28 cases * in all. Most of the operations were enucleations for "parenchymatous cysts"; two were total excisions (operations of great magnitude) for carcinoma. Of the six deaths, five were due to septicemia and pyemia, and the sixth to secondary hemorrhage, also, of course, the result of infection. Excluding the cases of carcinoma, there were only four deaths in 26 cases. The operation upon one of the carcinomata (1874) required four hours and 120 ligatures. A large piece of the left common carotid was excised. On the fourth day after the operation there was profuse secondary hemorrhage from the left common carotid which was controlled for three days by compression with the Ehrlich crutch. On the ninth day there was a fatal hemorrhage from the same vessel. Thus, except for infection, von Bruns would, probably, have had no fatality to record from operation upon the thyroid.

It is noteworthy that, in contrast to other surgeons of his day, as early as 1868,† he used the cutting edge of the knife to dissect, carefully, the tumor from the trachea.

Bruns exercised great care in controlling hemorrhage. Operations which he considered quite bloodless might not, however, be so regarded today. He did not, apparently, discover that the blood vessels of the thyroid gland had a distribution which varied little from a norm; nor, indeed, did Kocher until some years later (1883) [189] direct attention to the regularity in the arrangement of the arteries and veins and

* In Süskind's paper [330] these cases are tabulated, and 10 of the most important ones are recorded in detail.

† Desault in 1701 and Dupuytren in 1808 (*vid.* table) carefully cut the isthmus away from the trachea. Then for 60 years and more, surgeons of all countries, fearing to dissect the isthmus from the trachea, treated it as a pedicle, with clamp and cautery, écraseur, transfixion, ligatures, etc.

recommend ligation of the thyroid arteries as a step in the operation preliminary to the excision of a lobe. Bruns ligated vessels only as they presented, liberating first the more loosely attached parts of the tumor.

His dissection was made bluntly, sometimes with specially designed tips which could be forcibly separated by pressing the handles of his polyspeculum; or, the tissues to be divided were canalized layerwise with Cooper's scissors, the fingers or the handle of a knife. Along the passage thus made a ligature-needle would be passed, and the tissues, including vessels, would be divided between the two ligatures."

I was pleased to find in Süskind's dissertation (*l. c.*, 1877) a list of instruments employed by Bruns in his operations for goitre: "Several pointed bistouries, several forceps * (preferably toothed forceps), Cooper's scissors, one aneurism-needle (preferably the blunt, ligation-needle of Bruns), a Muzeux's hooked forceps † (Vulsella) or a fenestrated forceps, ligature-rods of Gräfe or Dupuytren, catgut and silk, sponges, water, blunt hooks."

No mention is made of artery forceps; this may be an oversight, for Bruns in his *Handbuch der chirurgischen Praxis,* vol. i, p. 29, says: "The ordinary forceps which are closed by finger pressure ‡ can be held permanently closed by various devices, among which the Schiebervorrichtung of Fricke has proved to be best suited to the purpose. Most frequently such lockable forceps are employed for the tying of bleeding arteries and hence have been named artery forceps, although they are often used to grasp the cut edges of the skin or mucous membrane, or bits of sponge with which blood and mucus are wiped away. For all these purposes I use preferably the forceps represented in Fig. 37" (*l. c.*, p. 29). Another forceps used by Bruns is figured on p. 240 of his book.

The above quotation convinces one that the artery forceps was not used very frequently, and that the idea of leaving two or more clamps hanging in a wound had not been evolved.

The contributions of Billroth to the surgery of goitre would not from his own pen seem to be nearly so important as Kocher's, but the significance of his work is reflected in the writings and contributions from his school—of his assistants, notably Wölfler, von Mikulicz, von Eiselsberg, von Haberer and Schloffer.

* Dissecting forceps is meant.

† Vulsella forceps was used for the hard tumors and a fenestrated forceps for the soft ones.

‡ Our thumb forceps.

Wölfler's voluminous and classic monographs on the development and structure of the thyroid gland and of goitre [365, 370] resulted from the study of Billroth's operative material. Von Mikulicz gave to the world his method of resection of both lobes; from von Eiselsberg and from his school has come fundamental experimental work on transplantation of the thyroid and parathyroid glands; von Haberer has greatly stimulated interest in the thymus, and by his operative studies on the human subject has lent support to the views of Garrè, Rehn and Klose, and of Garrè's assistants notably Capelle and Bayer. Schloffer has developed an operation for goitre which closely resembles mine. In the early eighties Billroth had operated upon more cases of goitre than any one in the world, had emphasized the danger of wounding the recurrent laryngeal nerve in performing the operation of lobectomy, and had furnished many sad examples of tetany consequent upon total extirpation of the gland.

Theodorus Billroth.* *Chirurgische Klinik, Zürich, 1860-67.* Berlin, 1869, p. 167.

"Fasse ich das Resultat meiner Kropfoperationen zusammen, ohne Rücksicht auf die besonderen Verhältnisse der einzelnen Fälle, so ist es kurz folgendes:

	Mal	Geheilt	Gebessert	Ungeheilt	Gestorben
1. Cystenkröpfe:					
Punction	2	..	..	2	..
Punction, Drainage	1	1	..	..	..
Incision, Vernähung von Cystenwand und Haut	10	8	..	..	2
Punction, Iodinjection	20	18	..	2	..
2. Feste Kropfgeschwülste:					
Subcutane Zerreissung	3	1	1	1	..
Aetzung	1	..	..	..	1
Tenotomie	2	..	1	..	1
Exstirpation	20	12	..	..	8
	59	40	2	5	12"

Eagerly I have refreshed my memory of Billroth's experiences with the surgical treatment of goitre in the eventful days of his directorship of the surgical clinic of the University of Zürich; and I wish there were space to quote him at greater length.

* On the 1st of April, 1861, in his 31st year, Theodorus Billroth assumed the responsibilities of the surgical clinic in the University of Zürich. On the 21st of August, 1867, he was called to the chair of surgery in Vienna.

Billroth's account of his treatment of tumors of the thyroid by operation, "subcutane Zerreissung," which he performed in only three cases and abandoned after the first fatality, strikingly testifies to his earnest effort to cure his patients, to his zeal in carrying out personally every detail of the treatment, and to his desire at first to avoid operation with the knife. Of the 20 extirpations which he performed, eight of the patients died, although 18 of the operations were merely enucleations of circumscribed growths. In one case (No. 16) he performed successfully a one-sided lobectomy, and in one (No. 17) he excised the whole gland, with fatal result in 48 hours.

Case No. 17 (*l. c.*, p. 176): "Verena N., *æt.* 29. Excessive dyspnea. The trachea, especially at its entrance into the chest, was compressed by many nodules in the thyroid gland. Extirpation of the entire gland. After the operation the patient could not swallow. Collapse and death in 48 hours. At the autopsy the right recurrent laryngeal nerve was found to be included in the ligature about the inferior thyroid artery."

P. 179: "To him who has had little practice in these operations it can easily happen that he removes the entire half of the gland instead of merely the tumor, whereby the operation becomes very complicated and more dangerous. The extirpation of the entire gland is not so exceedingly difficult and can be accomplished without great bleeding; *but whether human beings can survive it has not yet been determined.*"*

The deaths following Billroth's operations were due to infection. One patient (No. 17), the only double lobectomy, died of "collapse"—probably from hemorrhage. Thus Billroth, who later, in Vienna, was to accomplish so much in the operative treatment of goitre, contributed little to its advancement during his 6½ years in Zürich.

Billroth's Clinic in Vienna. Reported by Anton Wölfler, *Zur Chirurgischen Behandlung des Kropfes.* Arch. f. klin. Chir., Berlin, 1879, Bd. xxiv, p. 157.

Believing that the operative methods of treating the various forms of goitre have been perfected, Wölfler thinks it would be unnecessary to write further on this theme were it not for the new questions raised by the advances made in the treatment of wounds. He confines his report to the consideration of cases of goitre treated in the clinic of Billroth in the academic year of 1877-78. A great number of patients with so-called parenchymatous goitres were treated with injections of iodine. Among these were not only the "diffuse hypertrophic forms"

* Italics mine (W. S. H.).

which Kocher considered the only ones suitable for iodine injections, but also soft goitres ("struma follicularis mollis") and other varieties "which probably stand midway between the two." Certain cysts responded to iodine injections in a remarkably favorable manner; others were uninfluenced by this treatment. Unqualifiedly condemned is the method of Mackenzie[217] (injections of chloride of iron) on account of the danger of embolism.

Wölfler reviews the use of the setaceum, the wick, the hair seton, cannula, incision, thorough drainage, etc., and concludes as a result of their experience with the Lister treatment that incision with drainage of cysts has a promising future.

The physical characters of the goitre particularly interested the surgeon. Was it solid or cystic or vascular—a tumor suitable for parenchymatous injection, "Zerreissung," seton, drainage, enucleation, or to be let alone?

It interests me to note that Wölfler strongly recommends the use of penghawar djambi * for checking hemorrhage in papillary cysts which bleed after incision. During this and the following year (1879 and 1880) I studied in Vienna, and observing that penghawar djambi was used quite frequently in the clinic of Billroth, I obtained some of it from Wölfler, who only a few years ago very kindly sent me a fresh supply of this curious natural styptic wool. I have never had occasion to use it.

Wölfler asks if it might not be justifiable to extirpate cystic goitres notwithstanding the vehemently adverse pronouncement of Gurlt and others and, finally, reports the results of seven extirpations of goitre with the antiseptic method of Lister. Prompt healing was obtained in every case. He wonders why so few operations upon the thyroid gland had been undertaken in America and France; and particularly in England, where ovarian cysts had been removed one hundred times as frequently as goitres; "whereas with us the contra-indications are becoming constantly fewer and the number of operations are steadily increasing." He finds the answer in the better control of hemorrhage, in the antiseptic technique and in the new indication for operation based on the teaching of Rose that the tracheal rings become softened by the pressure of goitres. The intimation that the surgeons of England, France and America were not so advanced in the

*** Paleæ hæmostaticæ. Root hairs of the East Indian bullock tree (Baumfarren).**

art of controlling hemorrhage and in the science of the treatment of wounds was fully justified. Whereas most of the better surgeons of Germany and Austria and Switzerland promptly and eagerly accepted the teachings of Lister there were few in England, France or America who did so until nearly a quarter of a century later. Indeed, our surgeons were novices as compared with the Germans in the art as well as the science of surgery in those days.

But Wölfler's memory seems to have been short, for hardly more than a year had passed since Billroth, ever mindful of his disastrous experiences of the previous decade in Zürich, had ventured to operate again upon goitres; and the acquired confidence was based chiefly on results obtained with the antiseptic method of Lister, a gift from England.

In this series (1877-78) of Billroth were, for the first time, cases operated upon for cosmetic reasons and for moderate difficulty in breathing—" none because life was threatened." Also a definite method of operating had been evolved. The incision was made along the sterno-mastoid, and the division of this muscle abandoned. The sterno-hyoid, sterno-thyroid and usually the omo-hyoid muscles were divided transversely. The capsule was slit up on a grooved director, its veins being avoided as much as possible.

Clamps had come into use and Billroth was evidently learning some of the various purposes which they were to serve; for example, he divided tissues containing vessels between two of them and would leave a number hanging in the wound. Where the binding structures were short, an aneurism-needle was employed. The thyroid vessels were not sought for and isolated; all vessels were tied en masse as encountered. " The searching for special vessels did not seem worth while, because the operation would thereby be lengthened and be made bloodier than it was when step for step ligatures en masse were applied. And, moreover, it seemed questionable whether wound surfaces would unite primarily if 60 to 100 ligatures remained and in part came to be opposed to one another." In order to avoid the danger to which tying en masse exposed the recurrent nerve, Billroth included less tissue in the ligatures when working in the vicinity of the inferior thyroid artery and ligated this artery separately, as it was met with in the course of the operation.

Abstracts are given in this paper by Wölfler of the seven cases operated upon by Billroth in the academic year 1877-78.

These records have especial interest for me, because they tell the story of the early experiences with Listerism of Austria's great surgeon, and also for the reason that I was studying in Vienna (1879-80) and occasionally attended the clinic of Billroth at this period when the science of surgery was beginning to reveal promises of a marvellous future.

I regret that the early operations on the thyroid gland by Billroth are not reported in greater detail. From the data given I am quite sure that lobectomy, more or less complete, was performed on one side in three of the cases (Nos. 1, 6 and 7), and extirpation of a circumscribed tumor in three (Nos. 2, 3 and 4).

In case No. 2, a cystic papillomatous adenoma, the hemorrhage was so great from one of the deep-lying cysts that complete extirpation was impossible. The bleeding was stopped by stuffing with penghawar djambi.

In case No. 5, total extirpation of the gland was probably made, at least in the sense that no thyroid tissue was left unremoved. Both lobes had apparently been replaced by adenomata. The left recurrent nerve was paralyzed as a result of the operation.

In case No. 7, "Struma carcinomatosa," there were "ganz enorme Blutungen." Sudden collapse occurred from the entrance of air into a vein, but the patient recovered and the operation was completed. The internal jugular vein had to be ligated.

Billroth's Clinic in Vienna. Reported by Anton Wölfler. *Weitere Beiträge zur chirurgischen Behandlung des Kropfes.* Wien. med. Wochenschr., 1879, Bd. xxix, pp. 733, 758, 782, 810, 831.

This paper followed promptly the preceding one on the same subject and is continued through five numbers of the Wiener medicinische Wochenschrift. Nine more cases (Nos. 8 to 16) of successful goitre-extirpation are reported.

With the growth of Billroth's experience in operating and in the antiseptic treatment of wounds his confidence keeps pace, and we find in this report operations of greater magnitude than before—three total extirpations and one lobectomy plus an enucleation on the opposite side. Wölfler contrasts the work of his countryman with that of the surgeons of other lands, condemning particularly and quite properly the operative method of Warren Greene (*l. c.*), which he terms, not inaptly, an "énucléation à tout prix," and bestowing insufficient praise

upon Patrick Watson (*l. c.*) whom, true to the error of Süskind, he credits to England instead of to Scotland. He justly criticizes Watson's extracapsular method, but he should have borne in mind the fact that Watson was scoring 5 consecutive recoveries from lobectomy and total extirpation of the thyroid gland (1871-74) in the years when Billroth, discouraged by the memory of his unfavorable results with operations upon the thyroid gland in Zürich (1860-67), was resting on his oars so far as thyroidectomies were concerned. Undeniably, Billroth's method in 1878 was better than Watson's in 1871-74; and in justice to Billroth it must be recalled that his deaths in Zürich were with one exception due to sepsis. On the other hand, Watson had to work quite without artery clamps; whereas Billroth, thanks to intercurrent inventions and to greatly increased operative practice following the advent of antiseptic surgery, had become, in 1878, fairly conversant with their uses.

We should particularly bear in mind, also, the important fact that in German-speaking countries patients were directed in great streams to the university hospitals and that Billroth was director of Austria's greatest surgical clinic; whereas in Great Britain adequate opportunities to operate usually came late in his life, if at all, to the surgeon and the number of cases at his disposal was pitifully small. Furthermore, Billroth's surgical activities were always in countries where goitre is prevalent.

Case No. 11 (*l. c.*, p. 760): *Totale Exstirpation einer strumösen Schilddrüse, definitive Heilung nach 20 Tagen.* This is Billroth's first case of tetany, and his first total extirpation with successful result. Wölfler writes of it:

"This case yields us several facts of clinical interest: it demonstrates that total extirpation of the thyroid gland seems under certain circumstances not only to be demanded, but also that the operation may be performed with as little danger as the simple shelling out of the goitre.

. . . . "It was further noteworthy that after extirpation the patient's voice became hoarse. Dr. Catti ascertained by laryngoscopic examination that there was right-sided paralysis of the vocal cord. Besides this, other symptoms appeared which led us to conjecture that these symptoms might be connected with the loss of the thyroid gland.

"A few days after the operation the patient surprised those around her by her singularly restless and dissatisfied demeanor; she complained continually of sleeplessness, and importuned constantly the physicians and attendants to do something to relieve her since her

condition was worse than before the operation. Since the local and general conditions seemed to leave nothing to be desired it was thought that she was feigning the symptoms of which she complained.

"On the evening of the sixth day the patient was seized with convulsions of the extremities, without losing consciousness. She was greatly agitated, cheeks red, pupils dilated, respiration labored, all extremities cool, pulse 65; at the same time she complained of pains in the head, dazzling before the eyes, roaring in the ears and a feeling of pressure in the chest.

"On the 19th of November the patient had a second attack, and on the 21st, a third; but these last were much milder than the first attack. The whole clinical picture tallied so completely with that which had been observed by Landois, and besides by Hermann and Escher in the experimental production of hyperemia of the brain, that one must conclude that the conditions of the circulation of the blood in the brain had undergone a change by the complete removal of the thyroid gland. Even though the correctness of this conception cannot at present be denied, it is, nevertheless, questionable, since the patient suffered from an anteflexion of the uterus, and her ovaries, palpable per vaginam, were sensitive to pressure—symptoms suggestive of hysteria. There remained, nevertheless, as cause for suspension of judgment, the asseveration of the patient that before the operation she had never suffered from such attacks, and also the circumstance that during the subsequent four weeks of her stay in the hospital she was quiet and contented, that the attacks were not repeated and that sleep returned."

The symptoms described by Wölfler in this case seem clearly to signify tetany—the first, following operation, that I have found recorded. Indeed, so far as I am able to judge from a careful reading of the published cases, no one except Sick (*l. c.*, 1867) and Kocher (two cases, *l. c.*, 1874) had hitherto excised the thyroid gland so radically. The parathyroid glandules, consequently, had probably never before been destroyed unless possibly in Billroth's case of Verona N. (*l. c.*), a patient who died too soon (48 hours) after operation for tetany to have developed.

"One of the patients (No. 16) of the series had to be tracheotomized in the course of the operation. In the act of dissecting off the isthmus the softened trachea suddenly bent on itself at an angle, the patient ceased to breathe, and all efforts to restore the respiration being fruitless, the trachea was opened and the operation completed. By subsequent laryngoscopic examination it was discovered that there was paralysis of the left vocal cord; nevertheless, the movements of the epiglottis remained normal. Comparing this observation with that made before operation, it is found that the left vocal cord, which before the opera-

tion had acted more sluggishly than the right, was paralyzed, and that the epiglottis in this case was not affected by the paralysis. We shall return later to the explanation of this peculiarity.

"Four weeks later, when the wound in the trachea was cicatrized and the patient had begun to speak aloud, another laryngoscopic examination was made. It was interesting to discover that the opening of the previously compressed and softened trachea now appeared perfectly normal and that the closure of the glottis was now exact."

Résumé by Wölfler (l. c., p. 832) of the 16 Cases of Billroth's Antiseptic Series

"In the last year and a half, as has been stated, Professor Billroth performed 16 operations for extirpation of goitre with antiseptic methods. In all the cases healing took place in from one to five weeks.

"The size of the goitres varied from that of a walnut to that of a man's head and over.

"The age of the patients was from 19 to 65 years.

"Total extirpation of the affected thyroid gland was undertaken in three cases; in one case the middle and right thyroid lobes were extirpated; in all the remaining 12 cases the tumor only was excised.

"The operation was most frequently performed on account of increasing difficulty in breathing; in about five less important cases it was for cosmetic reasons, and in some cases for both.

"In the case of a woman with papilloma of the thyroid gland severe hemorrhages necessitated rapid extirpation.

"The technique of the operation was, aside from some unessential variations, in most of the cases the same, and can, therefore, be briefly summarized as follows:

"1. Exact cleansing of the field of operation;

"2. Under thymol spray a linear skin incision along the inner edge of the sterno-cleido-mastoid muscle (in one case a flap was made);

"3. Division of the superficial and deep fascia of the neck on the director; double ligation of the superficial veins. For all ligations silk, boiled in carbolic acid solution according to the method of Czerny, was used, catgut, never;

"4. Splitting of the capsule on a director, or, when many veins were encountered, division between two clamps;

"5. Attempt to free the goitre bluntly; if this does not succeed;

"6. Divide all obstructing bands between two artery clamps and ligate en masse;

"7. Ligation of the superior thyroid artery; excision of the goitre from above downwards; isolation and ligation of the inferior thyroid artery;

"8. If total extirpation is undertaken, the same procedure is followed on the opposite side;

"9. Careful excision of the goitre with special attention to the freeing of the isthmus from the trachea; here, also, two clamps may

be employed; or, if the adhesion is slight, an aneurism-needle may be passed through on the proximal side and a clamp applied peripherally to the goitre;

"10. Thorough washing out of the wound with thymol; introduction of two to three medium-sized drainage-tubes; stitching with two to three plate-sutures and a corresponding number of interrupted stitches;

"11. Application of an antiseptic dressing covering the chest, neck and head;

"12. The drainage-tubes and the plate-sutures are removed on the third or fourth day, the interrupted sutures on the sixth to the eighth day; later, the fresh scar is covered with an ointment bandage. As several of the above-mentioned procedures which have already become typical of our clinic have been described in our previous communication, there remain only a few other matters to be discussed in detail."

Paralysis of the Vocal Cords Following Goitre-Extirpations *

"It appears quite remarkable that in each of the last six cases, in which Dr. Catti made careful laryngoscopic examination after operation, a one-sided paralysis of the vocal cord was observed. In one case (No. 11) we could not be sure that paralysis of the vocal cord had not been present before operation; and also in case No. 16 it was noticed prior to operation that the left vocal cord, which became paralyzed later, acted more sluggishly than the right (atony of the vocal cord); in the other four cases, however, of one-sided paralysis of the vocal cord closure of the glottis was exact before operation.

"It should be emphasized that in each of the three cases of total extirpation of the thyroid gland paralysis of the vocal cord occurred on one side only.

"In the first days after operation a paralysis of the recurrent nerve may be suspected if the patient chokes in attempting to swallow fluids; this indicates that the epiglottis is no longer able to close the glottis accurately.

"Fortunately these one-sided paralyses of the epiglottis improve markedly after the first or second day. If such patients are later examined laryngoscopically, it is seen on phonation that only that edge of the epiglottis sinks which does not correspond to the paralyzed side and that the epiglottis must make a sort of twisting movement in order to close the entrance of the larynx. It was also noticed in most of the patients that in the course of four to six weeks the voice became less hoarse, or that the hoarseness almost entirely disappeared. This improvement in the speech, which is noticed in paralysis of the recurrent nerve produced by other causes, is not due to the restoration in so short a time of the function of the paralyzed vocal cord, but to the fact that the healthy cord, being approximately gradually to the paralyzed one, effects an almost complete closure of the glottis; the voice, then,

* *L. c.*, pp. 833-6.

though not so hoarse, is still weaker than normal. This improvement in the speech may be the reason why so few authors have thought it necessary to make an examination of the vocal cords after extirpation of a goitre.

"The fact that one-sided paralysis of the recurrent nerve improves in this fashion is confirmed by many other observers (Türk, Mayer, Gerhart and others).

"A case very interesting in this connection was published by Klein (Jour. von Gräfe-Wälther, Bd. i, p. 130) in 1818: A young man had a goitre the size of an apple removed. During the operation he suddenly became speechless; thereupon the tumor was quickly ligated and cut off. The loss of voice lasted for three weeks; by degrees the patient began to speak again, 'his voice had changed into a harmonious bass.'

"It should be noted especially that sometimes a swelling of the arytenoid cartilage persisting for a time after operation likewise causes temporary incomplete closure of the glottis.

"The cause of these paralyses of the vocal cords is easily explainable if one remembers that in ligating the inferior thyroid artery the trunk of the recurrent nerve may be caught, ligated and cut through.

"This generally accepted explanation is justifiable only when, as in the three cases described by us, the one-sided paralysis is complete, where not only the one vocal cord, but also the corresponding half of the epiglottis is incapable of functioning.

"Ligation of a recurrent nerve in dogs produces paralysis not only of the vocal cord and the arytenoid cartilage, but also of the corresponding half of the epiglottis (Navratil, Berlin. klin. Wochenschr., 1871, p. 394).

"Therefore, if the vocal cord only is paralyzed then the trunk of the recurrent nerve cannot have been ligated.

"If one considers the anatomic position of the inferior laryngeal nerve and its topographical relation to the inferior thyroid artery, one sees that the trunk of the recurrent nerve, where it runs near the artery, lies so far inwards that it is not difficult to avoid it if one isolates the artery before tying.

"Based on the experience with the seven earlier cases of extirpation of goitre, Professor Billroth always makes it his particular aim to isolate the inferior thyroid before ligating it.

"It is remarkable that in spite of this precaution paralysis of the vocal cords occurred so frequently in our cases. Following the trunk of the recurrent nerve further upwards, one soon sees that it always rides over one of the branches of the inferior thyroid artery, and that, therefore, it is at this spot that there is danger of including it if the peripheral ligature is applied very near to the goitre.

"Therefore, no certain disproof can be offered that, in the three above-cited cases of complete one-sided paralysis, the recurrent nerve was not caught by the artery clamps.

"The cases of incomplete one-sided paralysis of the recurrent nerve (paralysis of the vocal cord only) cannot, therefore, be explained by the cutting of the trunk of the recurrent nerve.

"Following the recurrent nerve beyond its crossing of the branch of the inferior thyroid artery, it is seen that, gradually dividing into its filaments, the nerve runs along the posterior surface of the thyroid gland to the thyroid cartilage. If adherent to the capsule of the goitre, some of the fibres of the nerve may easily be torn in peeling out the tumor—a condition which may be responsible for most of the paralyses of the vocal cord.

"Thus, only, can one understand that sometimes there is an incomplete and at other times a complete paralysis of the recurrent nerve.

"It follows, therefore, that double ligation of the trunk of the inferior thyroid artery should be made as far as possible from its division into branches, and that the greatest care should be taken in freeing the goitre from the larynx and trachea in order that the branches of the inferior laryngeal nerve at this point shall not be torn."

Total Extirpation of the Degenerated Thyroid Gland

"According to the cases collected by Bruberger (*l. c.*) there have been 17 total extirpations of the thyroid gland, with two deaths.

"Adding to these the cases of Rose and Küster, and Billroth's new series of 16 cases, we have a total of 26 total extirpations, with four deaths—a mortality of 15.5 per cent.

"The suggestion to remove the whole thyroid gland instead of extirpating the goitre may be applicable to those localities where goitre is endemic; but where it is only sporadic the simpler procedure of enucleation of the tumor may well suffice. Professor Billroth decides on total extirpation only when the isolation of the goitre presents great technical difficulties, especially in those cases in which the goitre is intimately blended with the thyroid tissue. This much we know, moreover, that the removal of the degenerated thyroid gland in man is well borne, indeed so well, that from its loss we are not warranted in coming to any certain conclusion in regard to the physiology of the normal thyroid gland.

"And now some remarks on the dressings of the wounds in the last eight cases:

"As Professor Billroth advised in the Med. Wochenschrift, 1879, No. 1, we have used since November, 1878, for covering wounds, gauze impregnated with paraffin and kolofonium (not carbolized) from the Schaffhausener Fabrik. Apropos of this it must be emphasized that the wounds in the last eight cases of goitre extirpation—mostly very extensive operations—healed as quickly and with as little reaction as the earlier ones dressed with Lister's carbolic-acid gauze dressing.

"We observed, however, that in some of these cases swelling subsequently appeared about the margin of the wound, or that, the scar

breaking down at one point, slight suppuration would occur, and cease only when several silk ligatures came to the surface. The general condition of the patients was not further affected, although their stay in the hospital was lengthened from one to two weeks. Whether the suppuration was due to the silk ligature or to the tying off in mass of tissues, which having become necrotic could not readily be encapsulated when lying immediately beneath the skin, I do not venture to decide. Foreign bodies, especially needles, produce abscesses when they happen to be just under the skin, whereas they may lie for months or years in the deeper layers without exciting reaction.

" Professor Billroth inclines toward the latter view; against the first hypothesis speaks the circumstance that we observed in a large number of general cases as well as in several cases of goitre-extirpation that the carbolized silk ligatures healed in the wound without reaction."

In a postscript Wölfler states that in the course of the preceding few weeks Billroth operated successfully upon four additional cases of goitre (20 in all); two of these were total extirpations of the gland. It is interesting to note that whereas in the previous cases Billroth had cut his silk ligatures short, he left them long and hanging out of the wound in the last four, because the healing had been delayed a week or two by the late discharge of the short ligatures.

Billroth's Clinic in Vienna. Reported by Anton Wölfler. *Die Kropfexstirpationen an Hofr. Billroth's Klinik von 1877 bis 1881.* Wien. med. Wochenschr., 1882, Bd. xxxii, p. 5.

" Five years have now elapsed since Professor Billroth as result of his experience with the antiseptic treatment of wounds took up again the operative treatment of goitre and developed it in typical manner."

We may conclude, therefore, that during his first 10 years in Vienna, from 1867 to 1877, he rarely operated upon the thyroid gland, fearing to repeat his disastrous experiences in Zürich, where eight of his 20 patients operated upon for goitre died. In his preantiseptic period (1860-76) he operated upon 36 cases (Zürich 20, Vienna 16) with 13 deaths (36.1 per cent mortality). In his antiseptic period (1877-81) four of 48 cases (carcinoma excluded) died (8.3 per cent). Excluding five tracheotomized cases of this latter group, of the remaining 43, only one died (2.3 per cent).

As to the kind of operation performed, there were two enucleations (one death), 24 single lobectomies (one death), 22 total extirpations (two deaths). The recurrent laryngeal nerve was uninjured in 31 cases, paralyzed on one side in 11 cases, on both sides in two cases.

Death from tetany occurred in one of the cases of paralysis of both vocal cords. In the same year Riedel [206] reported paralysis of both laryngeal nerves from irrigation of the wound with a 2 per cent solution of carbolic acid after total excision of the thyroid.* The patient died of pneumonia following thyroidectomy.

N. Weiss. *Zur Pathologie und pathologischen Anatomie der Tetanie.* Wien. med. Wochenschr., 1883, Bd. xxxiii, p. 683.

Weiss reported on 13 cases of tetany which he had collected—Billroth (Vienna), eight cases; Albert (Vienna), two cases; Schönborn (Königsberg), two cases; Nicoladoni (Innsbruck), one case. The tetany had been observed only in young females and only after total extirpation of the gland. In three instances it had appeared within 24 hours of the operation, but usually not until several days thereafter—once as late as the tenth day. Having in mind a nervous origin (spinal cord) for the disease he emphasizes the fact that paralysis of the recurrent nerve occurred only in eight. Five patients recovered from the tetany, two died, and in one case the tetany still persisted (three years).

He discusses the question as to whether the operation was responsible for the tetany and decides in the affirmative. From his clinical and anatomico-pathological studies he is confident that tetany is due to a persistent condition of irritation in the anterior horns of the gray substance of the spinal cord. He believes that neither the operative insult, as such, nor the paralysis of the recurrent nerve, nor the elimination of any special function of the thyroid gland could cause this state of irritability of the spinal cord; he considers it far more possible, but not probable, that the ligation of the inferior thyroid arteries, by increasing the flow through the vertebrals may have caused hyperemia of the medulla oblongata and spinal cord and thus have brought about the disease; but he believes it highly probable that the ligation of so many blood vessels in the course of the goitre operation sets up an irritation of the peripheral sympathetic nerves, and thus, an excitation of the vascular centres of the cervical spinal cord and medulla, which in turn

* Recently in the surgical clinic of The Johns Hopkins Hospital the musculo-spiral nerve was paralyzed in a wound freely swabbed out with pure carbolic acid. The wound was thus vigorously sterilized in order to prevent infection of the blood-clot with which an involucral cavity was to be filled. In about three weeks the function of the nerve was completely restored.

brings about changes observed by him in the gray substance; namely, in the anterior horns of the spinal cord.

In three cases he found such definite changes in the ganglion cells of the anterior horns, particularly in the neighborhood of the fifth and sixth cervical roots, as to confirm his previous postulate that the cause of tetany is to be found in an irritable state of the ganglion cells of the spinal cord. He considered it, therefore, unnecessary longer to speak of tetany as a neurosis, but was inclined to classify it with the diseases of the gray substance of the spinal cord.

I have cited Weiss's views as to the cause of tetany chiefly as an introduction to the following remarks of Billroth, who took part in the discussion:

"There can be no doubt that tetanus and tetany are two perfectly distinct processes which have in common only the muscle cramps and the fact that they appear after operation. Tetanus, by the way, is beginning to become merely a matter of history. In the past 30 years I have seen only five or six cases, except in war-lazarets; and in Vienna only two cases in 16 years, and not one in the past 10 years.

"In most cases of tetanus there is trismus, which is not true of tetany; and tetanus follows wounds of the extremities. Tetany, on the other hand, seems to be due to conditions of irritation which proceed from the trunk and head. Tetanus and trismus are very dangerous; three-quarters of all cases die. From tetany most patients recover; it can, therefore, not be considered a milder form of tetanus. The unquestionable relation of tetany to goitre-extirpation naturally leads one to blame disturbances of circulation; but I doubt if this view is correct, for the following reasons: If we ligate both inferior thyroid arteries, an increase in pressure in the region of the subclavian can only occur when at the same time the routes for the returning blood have undergone a considerable change disadvantageous to the free circulation of the blood. But from the operation for goitre the alteration in conditions is favorable to freedom of the blood stream. The internal jugular vein is not ligated, but, on the contrary, is freed from the pressure of the goitre-mass. Moreover, in the neck collateral routes are so numerous that it is doubtful if an increase in the blood pressure could occur. If this were not so, one should expect something similar to be observed after ligation of the carotid, which, however, is not the case.

"The partial extirpation of the goitre, as hinted at by the speaker (Dr. Weiss), would be more dangerous than the total unless it were indicated by a preformed goitre; the essential progress rests, indeed, upon this, that we take away the entire tumor—that we tie first the superior and then the inferior thyroid artery in order to be able to work on unembarrassed. Were we compelled to cut through the middle of the goitre we should be confronted with a quite uncontrollable

hemorrhage.* It is possible that the division in great quantity of nerves and the ligation of many arteries play a rôle. But we often perform operations for the extirpation of neoplasms, which are just as formidable as the goitre excisions, and there ensues no tetany; I am inclined, therefore, to lay especial stress upon the division of the numerous nerves of the thyroid gland, and believe that tetany occurs only in those individuals who are predisposed to nervous affections. The number of deaths in consequence of tetany is, altogether, not very great.

"Concerning the anatomical findings, they seem to point to the conduction from the field of operation of a nutritional disturbance; the proximity of the brain and spinal cord may have considerable significance; these lesions (those described by Dr. Weiss) may perhaps occur in every case, but they must be present to a considerable extent in order to produce the picture of tetany. As to the changes in the vicinity of the nerves, I would not attach great importance to them; infiltrations in the nerve-sheaths occur more or less with every injury. The essential thing seems to be a disturbance of nutrition which extends along the axis cylinders; if such nutritional disturbances from wounds are to be regarded as inflammation, then we must call this process inflammatory."

O. Kappeler. *Geschwülste des Halses. Chir. Beobachtungen aus dem Thurgauischen Kantonsspital Münsterlingen, 1865-70.* Frauenfeld, 1874, p. 99.

In the three years immediately following Billroth's term of service in Zürich, Kappeler enucleated encapsulated tumors in four cases and performed a lobectomy in one. All of the patients recovered.

He refers to the good service which a "Kreuzpincette" carrying a loop of thread might render, in the troublesome work of dealing with short vessels. So helpless were surgeons when confronted with blood vessels in the days before the introduction of the modern artery clamps.

A. Lücke. *Ueber die operative Behandlung des Kropfes.* Sammlung klin. Vorträge, Volkmann, Leipzig, 1870, No. 7 (Chirurgie, No. 3), p. 37.

Destined to play an important rôle in the drama of thyroid surgery was Lücke, eminent predecessor of Kocher in Bern; still in his prime, he died at the time when his record for goitre operations was the best in the world. Lücke's successful labors in this field could

* Billroth's view of the matter emphasizes the credit due to Mikulicz for the discovery three years later that, with proper preliminary precautions for the control of hemorrhage, there need be no bleeding on resecting a goitrous lobe.

hardly have failed to stimulate Kocher, who was little more than a boy when he assumed the responsibilities of the directorship of the surgical clinic of the university. We are indebted to his assistant Brière [53] for the publication of Lücke's results, as we are to Süskind for knowledge of the work of his venerated chief, Victor von Bruns, and to Wölfler for the valuable and scholarly exposition of the contributions of Billroth, the adored master, to the solution of this complex problem.

Lücke advocated parenchymatous injections with tincture of iodine, and warns against excision because of the danger of hemorrhage and infection; he stated that the ligation of the thyroid vessels as recommended by Philipp von Walther [349] had been condemned.

In 1873 Lücke published a *Bericht über die chirurgische Universitätsklinik in Bern von Ostern 1865 bis Ostern 1872,* D. Zeits. f. Chir., Leipzig, 1873, Bd. ii, p. 337, but concerning goitres there is only the following paragraph:

"Among the solid goitres there was one large calcareous goitre, and one vascular goitre; the remainder were in part treated according to my method with parenchymatous injections of iodine, and in part shelled out. Of 10 extirpations there was only one fatality. On the extirpation of goitre there has appeared a dissertation by my student Dr. Brière von Yverdon."

Brière in his inaugural dissertation on the surgical treatment of goitre records nine cases operated upon by Lücke in Bern—two in 1865, two in 1868, four in 1869, one in 1870. Lücke in his report of his clinic up to Easter, 1872, speaks of 10 extirpations, hence he operated upon one case only from 1870 to Easter, 1872. The nine cases selected by Lücke for operation and reported by Brière were, as I interpret the records, all circumscribed tumors, quite undoubtedly adenomata. Local infection with infiltration of the tissues of the neck so extreme as to completely obstruct the trachea was the cause of death in the single fatal case. Brière reports also three operations by Professor Emmert of Bern, one of which resulted in death, and tabulates 73 operations from the year 1785 to 1871, as follows:

	Nombre d'opérations	Guérisons	Morts
"Cas opérés (1785-1845)*	29	18	11
v. Walther †	2	2	—
v. Bruns ‡	5	3	2
Emmert §	3	2	1
Billroth ‖	20	12	8
Middeldorpf ¶	1	1	—
Schuh **	4	4	—
Lücke ††	9	8	1
Total	73	50	23"

"That Billroth's results were relatively so unfavorable is comprehensible if one bears in mind the fact that many of his patients were operated upon in extremis.

"The success of Lücke, on the other hand, is due not only to the skill of the surgeon and the prudence of the operative procedure, but also to the judgment exercised in discerning the indications favorable to operation."

Paul Sick. *Ueber die totale Exstirpation einer kropfig entarteten Schilddrüse und über die Rückwirkung dieser Operation auf die Circulationsverhältnisse im Kopfe.* Med. Corresp.-Blatt des Württembergischen Ärztlichen Vereins, Stuttgart, 1867, Bd. xxxvii, p. 199.

The following case of Sick's deserves special emphasis, because for the first time symptoms of thyroid deprivation were observed to follow the operation—a total removal, possibly the first, of the thyroid gland:

Boy, *æt.* 10. Tumor, size of apple, tense, elastic, in the midline and to the right of it. Extended from the sternal notch to the lower border of the thyroid cartilage and, "remarkable to relate, on deep inspiration disappeared completely behind the breastbone." It caused great difficulty in breathing. The tumor was first noticed in the spring of 1866,

"* Schmidt's Jahrbücher.

"† Zartmann, De Strumae Extirpatione, Bonnae, 1829.

"‡ Klein, Ein Beitrag zur chirurgischen Behandlung der Strumen, Tübingen, 1860.

"§ Brière, *l. c.*

"‖ Chirurgische Klinik, Zürich, 1860-67. Berlin, 1869.

"¶ Lebert, Die Krankheiten der Schilddrüse, und ihre Behandlung. Breslau, 1862.

"** Ausrottung eines Cancer fasciculatus der Schilddrüse und zweimal einer Struma glandulosa mittelst Galvanokaustik. Wien. med. Wochenschr., 1859, Jahr. 9, p. 641.

"†† Volkmann's Sammlung klinischer Vorträge, Nr. 7 (Chirurgie, Nr. 3), 1870."

about one year before Dr. Sick was consulted. Sept. 18, 1866: Exploratory puncture. Only blood, a few drops, came through the cannula. Operation immediately thereafter.

Chloroform. Superficial veins divided between two ligatures, carried under the vessels with an aneurism-needle (procedure attributed by Klein and Sick to von Bruns). All the vessels were secured in this fashion as they were encountered. Division of sterno-hyoid and sterno-thyroid muscles. Tumor completely freed, except for firm adhesions to the trachea. It was then found to be continuous with the left lobe, which, however, was not much enlarged, although on palpation it was hard in spots and partly embraced the trachea. The propriety of dividing the isthmus was debated, but it was finally decided to remove the left lobe. The vessels of the upper pole (unnamed) were divided as on the opposite side, but the central ligature slipped and the wound immediately filled with blood. Many futile attempts to catch the bleeding vessels were made. The spurting artery threw such a powerful jet that the operator's eye became blinded several times with the blood and it was thought that the carotid must have been divided. The operator recalled a precisely similar case in the Tübingen clinic in which the carotid had been ligated to control the bleeding and in which later a secondary hemorrhage had occurred. Pressure on the carotid was finally made and the spurting vessel secured with an artery forceps.*

The left lobe was finally freed and the entire gland clung only to the trachea over an area the size of a "bean." The patient suffered so greatly from cramp of the glottis on attempts to ligate the pedicle that the advisability of tracheotomy was considered. Finally, by tightening the ligature very gradually the cramp of the glottis was not reproduced and the gland could be cut away.

This may have been the first case of total excision of the thyroid gland. Bruberger (*l. c.*), however, tabulates it as a partial extirpation and 17 others as total. In my opinion these figures should be reversed, for the only extirpation which without question could have been total was Sick's. This matter I have discussed in connection with Bruberger's paper.

High fever. Pulse at one time 150, but in about 12 days the patient's condition was quite normal. In two months after the operation the patient was discharged with a small granulating wound.

The specimen removed—about five times the size of a normal gland—showed disseminated colloidal changes. Nov. 4: Letter from patient

* Klein[188] and others report similar experiences with less happy result. This is a happening which even today occurs, particularly in the practice of surgeons who still employ catgut for ligation. A few years ago, in the course of a week's visit to a clinic where many goitre operations were performed and catgut was exclusively employed, this accident occurred twice under my eyes and once on the patient's transit to the ward.

describes nasal hemorrhages. Dec. 12: Letter. Nasal bleedings have ceased, but there is a running from the nose which is so profuse that the upper lip has become raw. June 1, 1867: Boy has returned for examination. He seems in blooming health, but the father states that his psychical behavior is entirely changed. Formerly joyous and lively, he is now silent, quiet and dull.

Sick's is perhaps the most complete total extirpation, up to that time, of the thyroid gland; it supplies also, as I have said, the first report of the condition which we now recognize as status thyreoprivus. Previous cases had, with few exceptions, been excisions of circumscribed tumors, cystic or solid, or of more or less readily enucleable portions of colloid goitre. Thus, in the first case of total excision psychic symptoms were produced. Two explanations suggested themselves to the operator: (1) Disturbed circulation in the brain due to removal of the organ (thyroid gland) which was supposed to regulate it; (2) the thyroid might be the place where certain "Umsetzungen" of the blood constituents take place and with its removal the chemically altered condition of the blood might lead to qualitatively changed nutrition of the brain. The Medical Verein of Stuttgart (June 6, 1867), after due consideration, concluded that the second of these hypotheses had most to commend it.

Theodor Kocher. *Zur Pathologie und Therapie des Kropfes.* D. Zeitschr. f. Chir., Leipzig, 1874, Bd. iv, p. 417.

Hardly a year has passed since Kocher was called to the chair of surgery at the University of Bern in which one or more papers on goitre have not appeared from his pen.

Among Kocher's significant contributions to the subject are: (1) Discovery of the fact that total extirpation of the thyroid gland is followed by body changes, to which he gave the name cachexia thyreo- or strumipriva; (2) the studies with his life-long friend Langhans of malignant tumors of the thyroid gland; (3) the perfecting of the operation of thyroidectomy; (4) the stimulus which he gave to the operative treatment of Graves' disease and to the study of the milder forms of hyperthyroidism; (5) the recognition of engrafted forms of Graves' disease; (6) the demonstration of the value of the ligature of the arteries as a preliminary step to lobectomy, in the highly toxic cases; and (7) the danger of the indiscriminate administration of iodine to patients with goitre.

In 1872, Theodor Kocher, at the youthful age of 31,* succeeded Lücke as director of the surgical clinic in Bern, his native town. Stimulated, presumably, as I have said, by Lücke's success in the operative treatment of goitre and by the great number of patients suffering from this disease who must have applied for relief at the surgical clinic of Bern, Kocher in the first two years of his incumbency, was able to credit himself with 13 extirpation operations upon the thyroid gland. Among these were two total excisions and two évidement † or "Ausschälung" operations; the remainder were, seemingly, enucleations of circumscribed tumors. Two of his patients died—the first and the last, and from infection. In both of the cases of total excision recovery took place. Billroth, at this time, had, apparently, discontinued operating for goitre, being convinced that the danger, chiefly from sepsis, was too great. He had performed only one total excision; this patient died within 48 hours, probably from hemorrhage—plus, perhaps, infection. Kocher writes:

"The chief danger in extirpation is the profuse bleeding ‡ which occurs from the numerous arteries, but much more from the enormously developed venous plexus about the glandula thyroidea. To attempt to lessen the hemorrhage by ligating the four arteriae thyroideae, as has been proposed of late, seems theoretically very rational, *but such a procedure is almost identical with extirpation of the goitre itself.*" §

In six cases the indication for operation was dyspnea. In five of these the tumor was of the "goître plongeant" variety. The incision employed was either along the edge of the sterno-mastoid muscle (for laterally situated tumors) or in the midline.

"It is absolutely essential for the most successful carrying out of the operation that the operator should not permit himself to be frightened off by any difficulty from dissecting down to the goitre tissue proper; he must not leave the thinnest connective tissue capsule undivided. *It would be better to cut into the goitre itself, to make sure, rather than in the deliverance of the tumor behind, to find oneself floundering in the lateral tissues of the neck.*"*

* Billroth was in his 30th year when he was called to Vienna.

† The exposed tumor having been split in two was shelled out with the finger or sharp spoon from within the capsule which was then sewed to the incised edges of the skin. Lücke terms the method an "intracapsuläre Ausschälung."

‡ Kocher had lost no case from hemorrhage.

§ Italics mine (W. S. H.).

It is interesting, further, to note Kocher's method, at that period, of managing the blood vessels of the pedicle.

"At the posterior periphery of the tumor there occur regularly, even when the operation has been properly conducted, strong, pedicle-like binding strands which often contain huge blood vessels. One reaches most quickly the goal by piercing and surrounding these bands with the artery-hook * and, according to their thickness, by dividing them into two, three or even into six parts and tying forcefully. There occur cases in which the final portion, often over a considerable area, is bound to the trachea by unstretchable adhesions. Under such conditions, *ligation in parts being impossible,*† one must have recourse to the ligature in toto and cut off the tumor with the knife, leaving a stump behind."

A few years later Kocher accomplished this step in the operation, in the manner which in 1874 he had considered impossible.

Particularly worthy of note is the observation of Kocher in the case of Marie Richsel, *æt.* 11 years, whose thyroid gland he had completely removed.

"According to the report of the physician she enjoyed unclouded health during the first two weeks after her return home, but latterly a remarkable change in the behavior of the child has taken place. She has become peevish and dull, and will not work except under compulsion, whereas formerly she was a spirited and joyous creature.

"*We shall learn from the further progress of the case whether there in any relation between the extirpatio strumæ and the altered mental condition*"‡.

This observation of Kocher's (Jan., 1874) § was made only a few months after Gull's (Oct., 1873) [148] description of a peculiar idiopathic condition in adults, to which two years later Ord [266] gave the name myxedema, and many years prior to Murray's discovery (1892) [259] that operative myxedema can be dissipated by the administration, subcutaneously, of thyroid extract.

* Aneurism-needle is probably meant, although "Arterienhaken" signified tenaculum also.

† Italics mine (W. S. H.).

‡ Italics mine (W. S. H.).

§ Sick, in 1867,[320] was, perhaps, the first to note these sequelæ of the operation. He was first also to perform successfully what was, except for a possible remnant on the trachea, a total lobectomy. In Patrick Watson's excisions of the entire gland it is probable that at the pedicle of each lobe a considerable stump of gland tissue remained.

Fagge in his paper (1871) [112] on sporadic cretinism occurring in England reported a case which began as late as the eighth year, but it had not occurred to him or to Gull that lack of thyroid gland might be responsible for the condition.

Greater advance was made in the operative treatment of goitre in the decade from 1873 to 1883 than in all the foregone years—I may say, than in all the years that have followed. Unquestionably this rapid progress was due chiefly to the possibilities and the impetus given by the introduction of antiseptic surgery. Germany, Austria and Switzerland were the countries whose surgeons accepted promptly the doctrines of Lister. It was the German surgeons, notably von Bruns, Bergmann, Schede, Kümmel, Neuber and Schimmelbusch, who did most to eliminate the unessential features of Listerism and to replace antisepsis with asepsis.

In 1883 Kocher [102] published a famous paper in which he considered the evil consequences of total strumectomy and standardized, may I say, the operation of thyroid lobectomy.

In the 10 eventful years above mentioned he had performed 101 operations upon the thyroid gland, a greater number than any one except Billroth, and in the 17 months preceding the publication of this paper he had operated upon 39 cases of non-malignant goitre with two deaths, the two fatalities occurring in quite hopeless cases operated upon in emergency. In the same period he had excised the thyroid gland four times for cancer, with only one death.

Kocher writes:

"Up to the present time (1883) I have performed 101 goitre-extirpations.* Thirteen of these patients died, a mortality of 12.8 per cent. A year ago there appeared in the Correspondenz-Blatt für schweizer Aerzte a publication on the indications and results of goitre-extirpations in which I endeavored to complete and then extended the statistics which, under the guidance of Bruns, Süskind had collated. Whereas before 1850 about 70 goitre extirpations are known to have been performed, the number in 1877 had risen to 146.†

* Kocher announces that he will hereafter employ the word "Strumectomie" instead of the ambiguous and troublesome name "Thyroidectomie."

† To Süskind's collection Kocher had added three cases of his own, two of Kappeler, five of Rose, two of Czerny (communicated by letter) and the 16 cases of Billroth reported by Wölfler to which I have made reference above.

"Whereas, according to Süskind and Wölfler, the mortality up to 1850 amounted to 41 per cent, it had decreased to 21.2 per cent for the 146 cases operated upon between 1850 and 1877."

In a characteristically thorough and painstaking manner, by correspondence as well as from the literature, Kocher was able to gather reports of 240 cases of non-malignant goitre operated upon since 1877. In this series there were 28 deaths, a mortality of only 11.6 per cent. In the same period (1877 to 1883) he collected 28 cases of operation for malignant struma, with 16 deaths, a mortality of 51.1 per cent. Appended to his paper are abstracts of 236 of the above-mentioned cases.

Kocher in this series *had no deaths from sepsis,* which had been responsible for all the fatal results save one (Billroth's case, No. 17) in the cases theretofore reported of von Bruns, Billroth, Lücke and Kocher, nor had he at any time lost a patient from hemorrhage, although he had stated in his first paper (1873) that "the chief danger in extirpation is the profuse bleeding." Thus, even in the days before artery clamps were generally in vogue, when the art of controlling hemorrhage was relatively crude, there were no deaths from loss of blood at the hands of these competent surgeons. Nevertheless, the operation of strumectomy still made great demands upon the fortitude and skill of the surgeon.

Kocher had made a careful study of the blood vessels of the thyroid gland, particularly of the veins, and as result of this evolved, as had Billroth independently, a method which is essentially the one he practises today. He writes:

"In the first place it must be emphasized that one must not permit oneself to be led astray by Virchow's pronouncement that the irregularities of the blood vessels, 'kaum bei einem anderen Organ grösser sein können.' In most cases the vessels conform in their arrangement to a perfectly definite plan."

Excellent lithographs illustrate the result of his studies of the circulation of the gland. He credits Watson (*l. c.*) and Michel (*l. c.*) with having advised, both of them in 1873, ligation of the thyroid arteries as a step in the operation preliminary to the extirpation, but condemns their method of ligating en masse, on account of the intimate relation of the recurrent nerve to the inferior thyroid artery.

"Furthermore," writes Kocher, "the bloodless exposure of the inferior arteries is made possible only by the previous double ligation and division of a number of veins. . . . . What makes the securing of the veins in goitre operations especially necessary is the avoidance of injury

to the recurrent laryngeal nerve. Wölfler was the first, in thorough manner, to call attention to this danger and to make clear the reasons for it. I must agree with him and Billroth that it is comparatively easy to spare this nerve when ligating the inferior thyroid artery. The artery must be isolated with precision before the ligature is applied, and the trunk of the artery must not be ligated near its point of entrance into the goitre, but laterally, at some distance from it."

Kocher's operation in 1883: To a vertical incision of skin from manubrium to cricoid cartilage was added an oblique incision outwards and upwards from the cricoid cartilage to the anterior border of the sterno-mastoid muscle (Kocher's Winkelschnitt). The chief object of this incision was to give the operator free access to the lower pole "where the largest veins develop," and to the trachea in the region of the gland's attachment. The oblique portion of the incision, which divided the platysma as well as the skin, crossed the subcutaneous veins and thus made possible, at the outset, the double ligation of the anterior and oblique jugular veins and, if necessary, of the external jugular also. The sterno-hyoid, sterno-thyroid and omo-hyoid muscles were then divided in line with the oblique cut of the skin.

"Contrary to Billroth and to our own earlier method, we no longer split the capsule of the goitre at this stage of the operation. Our further procedure is determined by the intention to isolate and ligate each of the larger arteries and veins before dividing it and especially by the desire to have completely freed the tumor before undertaking to separate its pedicle from the trachea.

"At the outset we proceed to ligate the superior artery and vein. By following the vessels on the anterior surface and mesial edge of the tumor to the extreme tip of the upper pole, one easily and surely is guided to the main trunks which form the stem-like continuation upwards and outwards of the upper pole. These vessels are then ligated and divided, having been isolated with the aid of a specially designed 'Kropfsonde,' provided with three grooves. Proceeding from the upper pole downwards along the outer edge one encounters the transverse vena thyroidea superior accessoria, in case it is present, and divides it after double ligation. Then, tracing along the mesial edge of the upper horn, one treats in the same manner the vena thyroidea communicans superior, which courses over the trachea along the upper edge of the isthmus. Thus the upper pole is free, and now one turns to the lower pole. If feasible, the finger is made to encircle the lower pole which is then drawn upwards. In the case of strongly compressing strumas causing considerable dyspnea it is often necessary for the sake of better narcosis to deliver the struma promptly, especially in cases of struma descendens.

"From the inner edge downwards there stretches the vena thyroidea ima, often a very large vessel, which must be ligated and divided. Outwards and downwards from the lower pole stretches the ordinarily smaller, but occasionally equally large, vena thyroidea inferior, and further to the side and upwards the transverse vena thyroidea inferior accessoria. Both of these must be doubly ligated. At the lower edge of the isthmus when there is a double vena thyroidea ima one may find a vein connecting the two; this may be called the vena thyroidea communicans inferior. Except for a few small irregular little veins, the tumor, at this stage, is held only by its pedicle; namely, by the isthmus which binds it to the upper rings of the trachea. The goitre is then rolled inwards and taken into the hand, and now the moment has arrived when one must keep close to the surface of the gland. The capsule (*the external capsule—not the capsula propria, which must remain intact*) * being split and the tumor thus further released, the trunk of the inferior thyroid artery must be isolated and tied far away from the tumor, as near as possible to the carotid. The isolation must be done with the greatest care, and one must assure oneself that the recurrent nerve is not being caught in the ligature. Keeping close to the gland, one works without haste along its posterior surface towards the trachea, and, relying on pressure to occlude the peripheral lumina, catches each spurting vessel as finely as possible. The isthmus being reached it is gradually divided as, one after the other, each vessel is secured.

"By following this method the recurrent nerve can often be beautifully dissected out; but injury to it can with certainty be avoided without this direct exposure. Since we have adhered strictly to this procedure the hoarseness, formerly so frequently observed after operation, has now become exceptional."

I have quoted from Kocher's description of his operation at such length that the reader, contrasting his method of 1874 with that of 1883, might note the progress made by him in nine years.

Whereas, formerly, he had urged the operator not to be frightened off by any difficulty from dissecting down to the goitre tissue proper, and hence to extirpate it from within its intrinsic capsule, he now dissects along the plane external to the external capsule (two planes removed), and only after he has ligated both thyroid arteries and delivered the tumor does he split the external capsule. He now accomplishes with ease the clean dissection of the "pedicle" (isthmus) from the trachea, tying each vessel as it spurts, an act which, in 1874, he thought insuperably difficult. Paralysis of the recurrent nerve, which very often was then observed, is now an accident of rare occurrence.

* Italics mine (W. S. H.).

The larger blood vessels are being isolated before tying, and ligation en masse of the pedicle, in toto or in parts, is in disfavor.

The value of the artery clamps is not likely to be overestimated. They determine methods and effect results impossible without them. They tranquilize the operator. In a wound that is perfectly dry, and in tissues never permitted to become even stained by blood, the operator, unperturbed, may work for hours without fatigue. The confidence gradually acquired from masterfulness in controlling hemorrhage gives to the surgeon the calm which is so essential for clear thinking and orderly procedure at the operating table.

In this classic paper Kocher makes a contribution to physiology even greater than to surgery. Eighteen patients of 34 with total excision returned for examination. Of these only two were free from the symptoms which we now know to be due to loss of the thyroid gland. He describes at length and discusses quite exhaustively the possible causes of the mental and other physical changes characteristic of hypothyroidism, notes the striking resemblance to cretinism, and for the syndrome proposes the name cachexia strumipriva:

"We prefer for the present to employ for the designation of this group of symptoms an altogether non-committing name (einen ganz unverfänglichen Namen). To designate the nutritional disturbances which accompany the disappearance of goitres after the administration of iodine the name goitre cachexia (Virchow) has been used, but with the addition of the adjective iodica; we see no objection to the employment for the time being of the name cachexia strumipriva."

And here, in a footnote, he makes the comment:

"It is to be emphasized that the picture of cachexia with rapid emaciation, increase in the pulse rate, etc., which has been observed after the disappearance of a goitre in consequence of and also without (von Roser) the employment of iodine bears no resemblance to the condition described by us."

Thus early is foreshadowed his work 35 years later on *Iod-Basedow.*[199]

In each of the two cases of total excision in which strumiprivic symptoms were not manifested it was observed that a nodule, presumably consisting of thyroid tissue, made its appearance after a time.

Many pages are devoted in this paper to the consideration of the possible cause or causes of the progressive anemia which was observed in the thyroidectomized patients:

"The question arises: would a faulty development or atrophy and softening of the trachea explain the high degree of progressive anemia

which occurred in these individuals? We believe so. The affirmative answer to this question would at the same time explain the anemia observed in general in cases of goitre, which most authors are inclined to regard as the cause of the goitre, but which in reality is the consequence."

It is interesting to follow the argumentation of a mind so exceptionally keen and sane as Kocher's in its futile efforts to explain insufficiently illuminated phenomena. For example: He had made, six years before, an excision, almost total, of the thyroid gland in a boy aged 17. For five years the boy enjoyed perfect health, then on recurrence of the goitre on one side, cretinoid symptoms appeared.

"*The change in the condition of the patient cannot be explained by the elimination of the function of the thyroid.** But there was opportunity for especially unfavorable action upon the trachea by the recurrent goitre."

Today we know that the symptoms were due to the further degeneration of the remaining portion of the thyroid. It had not occurred to him that increase in the size of the gland might signify diminished function. Once this interpretation could be conceded, the true relationship of the cretinoid condition to the colloidal hypertrophy of the thyroid would easily follow. And, conversely, even many years later the vascular and hyperplastic gland of exophthalmic goitre could not be accepted as the cause of the symptoms of Graves' disease.

And again: "As I have said, the thyroid gland is regarded by Liebermeister and Schiff as a regulator of the circulation of the brain. Guyon, Ricou, and Maiqueux have further elaborated this conception. According to Maiqueux (*vid.* Hermann, *Physiologie,* p. 464) the carotid becomes pulseless after prolonged holding of the breath and after violent muscular exertion. The thyroid gland, accordingly, serves as a safety valve against overfilling of the brain with blood, for the blood, instead of having only the internal jugular vein in which to be blocked, may fill also the thyroid veins; then by means of the thereby greatly swollen gland whose sheath is bound up with the fascia of the vessels of the neck, and by the simultaneous contraction of the pretracheal muscles, the carotid becomes compressed. According to numerous, not yet published, measurements of my former assistant, Dr. Meuli, the circumference of the head and of the neck is greatly increased in the reversed position of the body; this increase is observed to be most marked and to occur soonest in the neighborhood of the thyroid gland.

"It is quite conceivable that after removal of the thyroid gland more frequent disturbances of the circulation occur in the region of the head, and that it is these disturbances which have in train the

* Italics mine (W. S. H.).

bloated face as well as altered function of the brain and sluggishness of thought and speech; for, as explained, we cannot, without further evidence, attribute these symptoms to anemia alone.

"*We believe, therefore, that the symptoms which condition the picture of idiocy are probably determined by the disturbances of the cerebral circulation, while the cachexia is to be explained by the influence upon the breathing, upon the supply of oxygen, in so far, at least, as it may not be ascribed to the cutting out of that function of the thyroid gland which serves in the formation of the blood.**

"If the explanation of the fact observed by us that cretinoid changes follow excision of struma is correct, namely, that the alteration of the general condition is brought about by secondary changes, then we have advanced a point also in the interpretation of the association of goitre and cretinism in the same individual, one with goitrous parents.

"The occurrence of cretinism in consequence of goitre can, on the basis of the fact of its appearing after removal of the thyroid gland, be interpreted thus: We may suppose that in cretins nothing remains of the normal gland, that everything is pathologically altered and therefore this particular function of the gland is lost. Further investigation must devote especial attention to this matter and also to the relative size of the trachea in cretins."

It is remarkable, as I have said, that symptoms of tetany—and these were transitory—were observed in only one of the 18 cases of total extirpation of the thyroid which returned to Professor Kocher for examination. This is in striking contrast to the relatively frequent occurrence of tetany in the cases operated upon by Billroth in about the same period. The tetany was regarded by Kocher as an indication of particularly intense cerebral disturbance.

Theodor Kocher. *Bericht über weitere 250 Kropfexstirpationen.* Correspondenz-Blatt für schweizer Aerzte, Basel, 1889, Bd. xix, p. 1.

"Discussing in 1882 in this journal the question of the indications for extirpation of goitre on the basis of 58 operations, I found from a review of the statistics of the various operators that their mortality was 13.9 per cent; my own was approximately about as high—14.8 per cent. After careful determination of the cause of death in each case I felt justified in drawing the conclusion that this 13.9 per cent mortality was not the final verdict, that we might anticipate much greater success; indeed, I ventured to formulate the sentence, 'The timely excision of an ordinary goitre is an operation free from danger.' Justification for the expression of this favorable view was derived from the fact that the majority of the fatalities were attributable directly or indirectly to imperfect asepsis of the wound, and from the likelihood that with a perfect antiseptic technique the still existent chief danger would be

* Italics mine (W. S. H.).

eliminated. Then, in April, 1884, at the Twelfth Congress of the Deutsche Gesellschaft für Chirurgie in Berlin where I called attention to the cachexia strumipriva which follows goitre-extirpation, a danger referred to in single instances, but not as yet appreciated, I could add to my 58 excisions 43 others in which the mortality had fallen to 6.9 per cent, or, excluding the malignant strumas, to 5.1 per cent. Since then at the Bernese clinic (and my private clinic) we have performed 250 additional operations, and one might well be allowed to review again the results of this 5½-year period of activity, in order, on the one hand, to formulate for the physician something tangible in regard to the indication for goitre-excision, and, on the other hand, to give to a colleague here and there a hint as to the method of procedure which after a little practice might be useful. . . . . We have lost six of the 250 cases operated upon since our last publication. This would give a mortality of 2.4 per cent in contrast to 6.9 per cent for the statistics reported in 1883, and to 14.8 per cent in 1882. But small as this mortality is, it falls considerably if one includes in the computation only the ordinary goitres. By ordinary goitres we do not mean the easy or simple forms, for we were called upon to perform the operation under the most difficult circumstances; frequently the goitre was inflamed at the time of operation; more frequently we had to deal with deeply situated strumas, some of them completely buried within the thorax; and usually there was extreme dyspnea, due to stenosis of the trachea. Further, the operation was undertaken at times upon old individuals and upon badly nourished people. Under the term unusual goitres we include only the malignant ones and the gland of Basedow's disease.

". . . . Excluding the malignant strumas from our calculation there remains a mortality of only 1.3 per cent for the other forms of goitre. . . . . If further we subtract the five Basedow cases, the mortality for the remaining 225 becomes reduced to 0.8 per cent. . . . . One will therefore not consider it an exaggeration when we affirm that *the operation upon an ordinary goitre even under very difficult conditions, however large the growth and however old the patient, has been entirely robbed of its dangers,* that one has no longer need to speak of a mortality in consequence of the excision of a goitre."

In April, 1895, at the annual meeting in Berlin of the Deutsche Gesellschaft für Chirurgie, Kocher [194] announced that he had operated upon more than 1000 cases of goitre. Twelve years before, on the occasion of the presentation of his famous paper on *Cachexia thyreopriva,* he gave the results of operation in his first 100 cases. He had then established the fact that not one of his cases of total excision had escaped the cachexia. Since 1883, therefore, in only one instance had he removed the entire gland; in this exceptional case, and only in this one, the cachexia had developed. Tetany, regarded as the acute form of

the cachexia, manifested itself transitorily in a number of instances, but only once (operation for carcinoma) in severe form. In the 900 cases operated upon in the 12 years the mortality was a little over 1 per cent, exclusive of the malignant and Basedow cases.

A new series of 600 operations was reported by Kocher in 1898.[196] In this series for the first time his assistants, Roux, Tavel, Lanz, de Quervain, Schwyzer, Fischer, Albert Kocher and others, were permitted to operate upon some (150) of the patients. For more than two years he had employed cocaine anesthesia and states that the danger in complicated cases was greatly lessened thereby. Now, too, he recommends the collar incision:

"The first distinctive feature of our method consists in this, that we make, as a rule, a so-called collar incision, namely, a transverse bow-shaped cut with its convexity below, which leaves a much more beautiful scar than any other. This we have demonstrated sufficiently often before gatherings of physicians. Occasionally we make an angle cut (Winkelschnitt) which together with the collar incision we have described in detail in our book (*Operationslehre*).[195] . . . . Further, we do not, as we have so frequently seen, make a transverse division of the muscles; we go between them and free only above and partly the attachments of the muscles which stretch from the sternum to the larynx, of the sterno-hyoid and sterno-thyroid, in order to insure for them an intact nerve supply. . . . . As a third essential act of our method we regard the luxation of the goitre, a procedure already described by us. When the connective-tissue capsule has been split with precision down to the gland and, when necessary, the accessory veins described by us have been ligated, the circumference of the goitre is freed so that it can be rolled over to the tracheal side. This luxation being accomplished, the act of ligating the main vessels is made easier. This again we regard as one of the special features of our operation, that we make it a point to ligate these vessels before shelling out the goitre. . . . . This difficulty of determining beforehand the side on which to make the excision brings us to the question of total excision in the cases, for example, in which the surgeon ascertains too late that, having removed the larger lobe, it is the other lobe which is making the pressure on the trachea. It would seem useless to waste further words on this subject, after having in 1883 brought proof that each total excision in man leads to a greater or less danger of cachexia thyreopriva and since subsequent experiments and clinical observations have confirmed my statements. But we note from recent letters and publications that this question still agitates certain minds. Thus Munk in Berlin insists that the consequences of total excision are attributable to accidental traumatisms in course of the operation. And Bottini in a work on the surgery of the neck declares that he has not seen harm result from total excision of the

gland. It is superfluous for us to state that since the spring of 1883 we have made no total excision without compelling conditions. . . . . In this case both thyroid halves were removed because on both sides a high degree of pressure was exercised upon the trachea. In addition to circumstances such as this we find necessity for removing both halves when, in absence of a thin isthmus, the two lobes are welded together in a mass over the trachea. In such cases an attempt to divide the firm colloid masses may be accompanied with hemorrhage so severe that ex indicatione vitali one might better remove the whole tumor. With the exception of these two possibilities only the malignant nature of a struma can justify the total excision."

Kocher had not as yet learned how to deal with a thick isthmus.

I saw Kocher for the last time in the spring of 1914, when we spent four or five days together in Berlin attending the Congress of the Deutsche Gesellschaft für Chirurgie. At that time he was still performing in all except very exceptional cases a one-sided lobectomy. He never approved of the suggestion of Mikulicz to remove, as a regular procedure, the greater part of both lobes.*

Of the 600 new cases reported by Kocher in this paper of 1898, 556 were colloid strumas. Chloroform was the cause of the only fatality in this series. The patient had a greatly enlarged thymus gland. The mortality was only $\frac{1}{100}$ of 1 per cent.

At the 30th Congress der Deutschen Gesellschaft für Chirurgie, April, 1901, Kocher [197] reported a second thousand operations for goitre.

" We make, whenever possible, the excision of the half which exercises the greater pressure. It is not always quite easy to determine the side from which the chief pressure comes, and pressure upon the less culpable side often causes less dyspnea than when made upon the other (for reasons which will be developed later). Especially often we find that the larger nodule is on the right side and that on the left is the one more deeply situated and more forcibly pressing.

" Enucleation, a much bloodier and less reliable procedure, we resort to only in the very rare cases of recurrence (4 in 1000) of the goitre, or when there is atrophy of the other lobe, as one observes especially in cretins, or finally when the capsule of the gland is densely adherent.

" We make, as a rule, the transverse, symmetrical bow-incision through skin, platysma and fascia, then the median cut between the muscles, which are divided only in the most difficult cases; we ligate, where possible, the accessory veins which pass over the surface of the

*** In the cases of colloid goitres and in the milder forms of Graves' disease it is our practice to remove a part of each lobe, but not precisely in the manner practised by Mikulicz.**

goitre and afterwards the two main bundles containing the superior and inferior thyroid vessels; we luxate the goitre out of its adventitia, divide the isthmus and free the lobe, leaving in suitable cases the posterior capsule of the gland. For dividing the isthmus we have advantageously employed a tissue-crushing forceps which works like the modern angiotriptor, but not with the idea of crushing particularly the vessels, but rather of crushing through the tissues so that only the vessels remain for the ligature *—briefly, to avoid the ligation en masse which unfavorably influences primary healing.

"The results are as follows: Of 27 malignant strumas six died; of 20 cases operated upon for strumitis two succumbed, and two also of the Basedow cases. Of 929 benign strumas four died—a mortality of 0.4 per cent. The cause of death in one case was chloroform narcosis and status thymicus. We were compelled to anesthetize this child because he was unmanageable. One died of acute cachexia thyreopriva, one of poisoning by corrosive sublimate which, contrary to orders, had been used for disinfecting the skin, and, finally, one of pneumonia four weeks after an exothyreopexy. The operation in this last case was so bloody that it could not have been continued without immediate danger.

". . . . One may conclude, therefore, that in the excision of an ordinary goitre, however large and however great the difficulties, the danger of hemorrhage and of infection no longer plays a rôle. . . . . The danger in the operation for an intrathoracic struma is the hemorrhage. The patients suffer almost without exception from a high degree of constriction. When now one draws through the upper aperture of the thorax a struma immobilis whose diameter is greater than this space, the trachea becomes for the moment compressed, the dyspnea increases to the suffocation point, each little vein that is torn begins to bleed, not to mention the greater venae thyroideae imae, and the situation is critical. It is of first importance that one doubly ligates the accessible vessels from above, the superior thyroid artery and vein and especially the veins named by us *accessory;* also, that one divides the isthmus and completely isolates the cervical part of the tumor before one proceeds to dislocate the deepest nodule. Then is one prepared to deliver the goitre; indeed, it is often a matter of a genuine delivery which can only be accomplished with an obstetrical forceps and spoon. We have had constructed for this purpose a special goitre forceps and a goitre spoon, in order to be able to extract the tumor from the depths safely and quickly.

". . . . Worst of all are the cases in which the tumor is absolutely too large to pass through the aperture of the thorax. Then nothing helps short of breaking up the tumor as if it were a myoma; but the morcellement must not be done in gynecological fashion; one must practise the évidement described by me, and bore rapidly into the tumor

*** Mikulicz was the first to advocate this method and to discover that one might with impunity crush through the colloid masses.**

with the finger, breaking up the soft portions within the capsule, opening cysts (occasionally also an abscess) and draw out the tumor to the light of day. This method is truly decidedly more bloody and for its execution requires occasionally a tracheotomy. For such an emergency cannulæ are necessary, long enough to reach beyond the stenosis; they should be at hand in every case."

Within five years (from November, 1900, to August, 1905) Kocher[186] added another thousand (his third thousand) to his list of goitre-extirpations. Nine hundred and four operations were for the non-malignant and non-Basedow forms, for the "ordinary" forms of goitre. Three patients of this colloid group died; one death was from secondary hemorrhage in a case of congenital cachexia thyreopriva; a second, from pneumonia, after the wound was healed, in a patient with dilated heart and atrophic kidneys; the third fatality occurred in a patient with a high grade of myocarditis, who from childhood had been afflicted with paralysis of both recurrent laryngeal nerves.

"This result may, in a measure, be taken as a criterion for the prognosis of major operations in general, because a goitre-extirpation in most cases is a serious affair which makes high demands on the surgical art.

". . . . The glory of this happy outcome of our therapeutic endeavors to relieve an affliction so sore falls to the three luminaries (Dreigestern) Pasteur, Koch and Lister, on whom therefore with full justification we have conferred honorary membership in this society.* In exemplification of this fact one may glean pronouncements particularly of French authors from the years 1875 and 1885; thus Luton †, the discoverer of iodine injections, writes: 'Il y a lieu de s'étonner qu'une opération aussi redoutable soit encore sérieusement conseillé de nos jours.'"

Once or twice or three or more times each year, up to the spring of 1914, Professor Kocher published the results of his studies of the thyroid gland and its diseases. At the time of his death, July 27, 1917, approximately 5000 cases of goitre had been operated upon in his famous clinic. For nearly half a century Professor Kocher had been in surgical harness at Bern, toiling vigorously and triumphantly to the end.

J. L. Reverdin. *Accidents consécutifs à l'ablation totale du goître.* Société médicale de Genève, Séance du 13 septembre, 1882. Rev. méd. de la Suisse romande, Genève, 1882, t. ii, p. 539.

* Die Deutsche Gesellschaft für Chirurgie.

† Duget. Goitres et médication iodée interstitielle, Paris, 1886.

"M. J. L. Reverdin thereupon made a communication in regard to the happenings consecutive to the total ablation of goitres. Up to the present time he has performed 14 operations and has had only three deaths: in one case, the cause of death was pneumonia; in another, complex nervous manifestations; and in the third, a cancerous goitre, death occurred from suffocation in the course of the operation. Mons. J. L. Reverdin has observed, in the recovered cases, sequelæ hitherto undescribed, and to these he invites the attention of the society. Two or three months after the operation the patients have, for the most part, presented a state of feebleness, pallor, anemia, accompanied in two of them with edema of the face and hands, without albuminuria; in one, a contraction of the pupil, melancholy, heaviness; in another, the facies closely resembled that of the cretins. In the majority of the patients, this condition was a long time in disappearing, and in three of them it has continued already a year. Not one of the writers giving the subject consideration has called attention to these sequelæ of ablation of the thyroid gland, hypertrophied or otherwise affected.

"Mons. Kocher has, however, related to Mons. Reverdin that in a case observed by him the patient remained depressed and feeble after his recovery. Mons. J. L. Reverdin has observed a case of tetany following operation, and Mons. A. Reverdin a second one, which has recovered.

"What part does the nervous system take in the production of these phenomena? Should the irritation or insult to the great sympathetic be taken into consideration? Or, indeed, the thyroid body, whose functions are still obscure to the physiologists, has it played in hemopoiesis a rôle so important that its ablation could entail so profound a trouble in the economy? In view of these results Mons. J. L. Reverdin has modified his method. Formerly he removed the thyroid body in its entirety, when this was possible. Today he respects the enveloping membrane, or conserves a portion of the gland. From the removal of only one lobe of the thyroid body he has not had a consecutive accident."

Hence Reverdin anticipated Kocher by about one year, and appellated the train of symptoms which followed his total excisions of the thyroid gland *myxédème opératoire*.

Thus the story is brought to 1883, to the time when the art of operating for goitre, particularly by Billroth and Kocher and men of their school, had been almost perfected, relatively minor problems remaining to be solved.

Functional derangements of the thyroid and parathyroid glands have been only cursorily referred to in this paper, which concerns itself primarily with the development of the art of bloodless operating. Bearing incidentally on the vital problems of tetany and Graves'

disease, but particularly on the question of resection versus extirpation—concerning the advisability of removing parts and of leaving certain parts of both lobes—is a paper by Mikulicz (1886),[240] which, although it appeared three years later than the date set for the termination of the period of our study, is of such interest and importance as to demand conspicuous recognition in the operative story of goitre. Surgical art and science owe many a debt to the brilliant and charming Mikulicz of the great school of Billroth.

J. Mikulicz. *Beitrag zur Operation des Kropfes.* Wien. med. Wochenschr., 1886, Bd. xxxvi, pp. 1, 40, 70, 97.

In the three years from 1883 to 1886, as director of the surgical clinic of Krakau, Mikulicz performed 25 strumectomies without a fatal result. In seven cases the entire gland was excised; in eight, one lobe; in two, the middle lobe or isthmus; and in 8, resection according to a new method of his own which he describes for the first time in this paper.

Union by first intention was obtained in 20 cases. In one instance tracheotomy had to be performed; the wound, unclosed, was packed with iodoform gauze. In every case but one the indication for operation was an extreme degree of dyspnea from pressure of the goitre. "It is superfluous to state," writes Mikulicz, "that in every case in which the necessity for operation was not urgent, iodine treatment was first tried, usually in the form of parenchymatous injections." The excised tumor was in 24 cases a "benign parenchymatous or cystic goitre." * In one instance it was a carcinoma. The goitre in one patient was complicated with Morbus basedowii (case 23). The symptoms of Basedow's disease rapidly and, without doubt, unexpectedly subsided after the operation. In performing his operations Mikulicz followed implicitly the principles formulated by Billroth which his "friend Wölfler in numerous papers has so admirably described."

His purpose in writing the paper he gives as follows:

"The number of my cases is surely too small to affect particularly the operative statistics which we already possess of hundreds of cases of goitre; at most, they furnish, in this respect, material from a little-known goitre region, the Galician Carpathians, confirmatory of the

* Mikulicz, in a footnote says: "The classification of the adenomata as given in the splendid paper of Wölfler (*Ueber die Entwicklung und den Bau des Kropfes*, Berlin, 1883) was, unfortunately, not observed in the clinical histories, hence in this respect I am unable to specify the precise character of the growth."

experiences of surgeons in other lands in which goitre abounds. Nevertheless, I shall not hesitate to narrate my experiences, since they may shed light upon a matter which today dominates the whole question of operation for goitre. I refer to the general and local disturbances—tetany, cachexia strumipriva and paralysis of the muscles of the larynx—which follow strumectomy and which, together, demand either an essential curtailing of the indications for operation or a modification of the operative method. There is hardly an operation within the past few years which has given the surgeon so much gratification and, at the same time, so much anxiety and perplexity as the extirpation of goitre. Thanks to the efforts of Billroth and Kocher and to the influence of the antiseptic treatment of wounds, the technique of strumectomy has, in a short time, been so highly perfected that one, soon, will not hesitate to perform, solely for cosmetic reasons, an operation which Dieffenbach shuddered to contemplate.

"In fact, the antiseptic method guarantees to the wound from a goitre extirpation a healing more perfect than is seen in any operation of like magnitude. According to the latest statistics of Rotter there have been only 12 deaths in consequence of wound infection in 405 extirpations of non-malignant goitre in the period from 1877 to 1884. The brilliant results of Billroth and Kocher are well known. Several operators have had the good fortune to operate upon a series of cases without a mishap. Thus Pietrzikowski [275] reports 21 strumectomies successfully performed by Gussenbauer; and I have been so fortunate as to have had 25 operations without meeting with a death, although among these was one for Basedow's disease and one for struma maligna in which tracheotomy had to be performed—a complication which affects badly the prognosis.

". . . . Inasmuch as total extirpation complicates the wound conditions no more than partial excision of the gland, and since recurrence may take place, the former operation has more frequently been performed; indeed, Rose has advised that the radical procedure be made the rule. And already most surgeons had manifested a disposition to follow Rose's advice, when Kocher in his well-known address [192] on *Cachexia strumipriva* before the Twelfth Congress of Surgeons in Berlin took a decided stand against the total extirpation of the thyroid gland.

"A dissonance in the rejoicing over the goitre operations had already earlier been sounded by the frequently observed disturbances of the innervation of the muscles of the larynx. One referred these, however, at the outset, solely to rough injury of the recurrent nerve, which, it was hoped, would in the future, with the development of a finer technique be possible to avoid.

"Greater uneasiness was aroused by the tetany following thyroid operations, which was announced first from the clinic of Billroth. However, fatalities from this cause had only rarely been recorded. Liebrecht [214] in 351 operations met with only three deaths from this

cause—and in the milder cases the attacks had been permanently or temporarily controlled by chloral hydrate and other means.

"Without doubt it was the communications of Reverdin [193] and Kocher [192] concerning the so-called cachexia strumipriva which brought to most surgeons the conviction that the removal of the entire thyroid gland, notwithstanding antisepsis, was no harmless intervention. The sad results of total excision painted in such vivid colors by Kocher were soon confirmed by other observers. Julliard,[178] Baumgärtner,[13] Grundler [142] (Bruns clinic), and Pietrzikowski (*l. c.*, from Gussenbauer's clinic) have reported similar observations, so that now the number of cases of cachexia strumipriva has reached 36. To this collection I can add a case of my own which conforms to the picture delineated by Kocher.

"It is comprehensible that in the face of such lamentable experiences a vigorous opposition to the total excision of the thyroid gland should have manifested itself. And when Schiff, Wagner, Zesas, Horsley and others, from experiments on animals, had confirmed the above-cited experiences, one must acknowledge that they are not wrong who affirm that extirpation of the thyroid gland is, physiologically, prohibited.

". . . . But how shall we act in the future when confronted with cases which, notwithstanding, urgently demand excision of both lobes of the thyroid gland? By ignoring the facts, as Maas and Rotter do, progress towards the solution of the problem will surely not be made. I hold that the matter of cachexia strumipriva has certainly not altogether been cleared up; for me, furthermore, the causal relation between strumectomy and cachexia has not as yet been proved in all instances. I believe, at least, that not all of the described cases of cachexia are identical, and that, furthermore, the manifestations in many of them were not in consequence of the operation, but supervened independently. . . . . As long as it is not absolutely proved that the cachexia described by Kocher stands in no causal relation to the total excision we must, as much as possible, avoid this operation. Only in the case of malignant neoplasms is it unquestionably justifiable.

". . . . After all, is it not questionable whether the term cachexia strumipriva, selected by Kocher, is pertinent? As is well known, most varied hypotheses have been advanced in explanation of this sequel of total extirpation. This matter has already been so much discussed that it would not be worth while to consider analytically all the explanatory hypotheses which have been advanced, for we are not yet in possession of sufficient data to justify attempts to explain the symptoms of cachexia strumipriva. Only this much seems to me in high degree probable, that the acceptance of a specific function of the thyroid gland, as suggested by Reverdin, Bruns and others—be this the furnishing of a specific secretion or a contribution to the constituents of the blood or an activity (vaso-motor) regulating the circulation of the brain—does not suffice to solve the problem. Against this view are

the facts that the cachexia may occur at any period of life, and that these symptoms are not present in the majority of the patients operated upon. Furthermore, Kocher's theory of deficiency of oxygen due to atrophy and softening of the trachea does not seem to be in accord with the facts. Most plausible to me is the view of Baumgärtner, who ascribes the symptoms to disturbed innervation in consequence of direct injury to or later changes (cicatricial contraction, atrophy, suppuration) in nerves in the neighborhood of the field of operation. This would most satisfactorily explain why in one case there appear the severest manifestations, and in another none whatever.

"This conception would also best account for the altogether inexplicable occurrence of tetany after the operation as well as, aside from the paralysis of the recurrent nerve, the innervation-disturbances of the larynx. As regards the origin of the tetany, Billroth attaches particular importance to the severance of the numerous nerves of the gland, and N. Weiss considers it probable that the irritation of peripheral sympathetic nerves set up by the ligation of so many vessels brings about an active excitation of the vaso-motor centres of the medulla oblongata and cervical cord. The tetany and the consecutive innervation-disturbances of the larynx furnish, moreover, two further reasons which decidedly contraindicate excision."

Mikulicz then calls attention to a theretofore unreported sequel of total extirpation, viz., epileptic * attacks, which he had observed in two cases. In both instances tetany preceded the epileptiform seizures. In three of Mikulicz's seven total excisions of the thyroid tetany developed.

"As to the occurrence of tetany after total extirpation, it is frequently of brief duration and passes off without further consequences. But sometimes it terminates fatally (according to Liebrecht, 3 times in 7, and to N. Weiss, twice in 13 cases) . . . . In one of my cases of tetany the manifestations of cachexia strumipriva appeared later. This observation, which also Gussenbauer † had made in two cases, points to the association of the two affections. It is quite conceivable that both of them have origin in the same disturbances of innervation; namely, lesions of nerves in the vicinity of the thyroid gland."

These early experiments on human beings have particular interest for us because they will not be repeated except by accident or through ignorance or in cases of malignant tumor. In animals they can be duplicated exactly. Thus, in dogs, after complete extirpation of the thyroid and parathyroid glands with transplantation of the latter in a film of the former, symptoms of parathyroid deprivation appear

* Epilepsy has repeatedly been observed in cases of parathyroid privation (Westphal, Schultze, Hochhaus, Phleps, Halsted and others).

† *Vid.* Pietrzikowski, *l. c.*

promptly, but the myxedema, coming on slowly, does not usually attain its maximum development for several months (Halsted). In three of my dogs the maximum myxedema, reached in three or four months, was maintained for a month or more and then, gradually subsiding, disappeared. The promptly appearing symptoms of parathyroid deprivation cleared up more or less completely with the revivification of the transplanted glandules, whereas the manifestations of thyroid deficiency vanished only commensurately with the slow compensation from hypertrophy of the thyroid graft.[151] In the three dogs referred to only a tiny film of thyroid tissue was transplanted—just enough to make possible, without injury, the transference of the parathyroid gland from the neck to a preperitoneal pocket.

Injury to the recurrent laryngeal nerve is considered by Mikulicz at considerable length:

"As to the paralyses of the larynx muscles, they can occur after one-sided as well as after total extirpation of the goitre. Experience teaches, however, that they are much more likely to follow the complete excisions.

"Jankowski,[173] in a meritorious contribution, has collected the hitherto observed cases of paralysis of the laryngeal muscles after goitre excision. Paralysis occurred 87 times in 620 operations—14.03 per cent.* Of these 87 cases, 65 occurred after total, and only 22 after partial, extirpation of the goitre—a proportion of about 3 to 1. But one must reflect that the partial operation has been practised much more frequently than the total. According to the statistics of Liebrecht, there were, in 303 accurately described operations, 125 total and 178 partial extirpations. If we make our calculations from these figures we must conclude that paralyses of the laryngeal muscles occur more than four times as frequently after total as after partial excisions of goitre.

". . . . The question whether in each case of vocal cord paralysis a coarse injury, a division of the nerve, has taken place, I must, as result of my experiences which correspond with those of other surgeons, answer decidedly in the negative. I have, in each case, isolated the nerve with the greatest care, and, until it was clearly in view, have not proceeded to the ligation of the inferior thyroid artery or its branches. In Vienna I saw a great number of goitre operations performed by the masterhand of Billroth and learned the topography of this region under the most difficult relations. Nevertheless, it befell me to observe, in my 25 operations for goitre, a paralysis of the vocal cord in one case, and in three cases, increase of a pre-existing hoarseness."

* Undoubtedly the paralysis occurred much oftener than this. Laryngeal examinations were not made as a matter of routine.

In his third paper Mikulicz[240] explains how it happened that he hit upon the operation which he is about to describe—an operation which, with slight modifications, is the one which a number of surgeons, myself included, perform today. Most operators, particularly those who ascribed to the thyroid gland some special function (*i. e.,* regulation of the circulation of the brain), advised, following the lead of Kocher, the removal of only one-half of the goitre. Mikulicz, for reasons given in quotations which I have made from his papers, also discarded the total or radical operation.

"But it not infrequently happens," he writes, "that, having undertaken the operation with the intention of removing only one lobe, the surgeon finds it necessary to remove the other. I have several times found myself in this predicament. After a very large, forwardly displaced lobe had been excised there would appear for the first time the second lobe which had been concealed behind the trachea, which it surrounded, or been buried in great part behind the sternum. In such cases one takes a risk if he postpones removing this lobe in the expectation that it may atrophy. It was in a case of this kind that I first practised a method which I hope may best prevent the evil consequences of total extirpation. I extirpated, namely, the second lobe, only in part, resecting in such manner that a portion of the lobe remained in the neighborhood of the inferior thyroid artery.

"I ventured to do this because I had observed that *division and ligation of a quite massive isthmus could be accomplished without evil consequences;** the parenchyma of the thyroid gland must, therefore, be tolerant of the insult caused by ligature en masse. Hence I need not fear to sever the principal part of the goitre from the remains by means of mass-ligatures passed through the parenchyma."

Surgeons from the time of Desault had not hesitated—indeed, they were compelled—to cut or crush through the parenchyma, distal to their ligatures or écraseurs. But what Mikulicz evidently had in mind was the behavior of these crushed tissues in a wound treated antiseptically—a wound which should heal by first intention.

He did not fear hemorrhage as he must have done three years earlier when assistant to Billroth who, in 1883, in discussing Weiss's paper (*l. c.*) said: "Were we compelled to cut through the middle of the goitre we should be confronted with a quite uncontrollable hemorrhage." Hence resection of a goitre in a wound to be closed was, per se, a definite contribution.

* Italics mine (W. S. H.).

From Mikulicz's account of the first operation by his new method of resection it will be interesting to have recorded here the more important paragraphs:

"The very first attempt which I made (case No. 13) pleased me exceedingly. The patient, a peasant boy, *æt.* 16, was suffering from great dyspnea and hoarseness. The trachea, dislocated forwards, was compressed to such a degree of flatness that one could feel through the skin only a narrow ridge. On the 19th of May I began the operation with the intention of removing the left lobe and isthmus and with the hope that the right lobe might be left undisturbed. But in the course of the operation it developed that the latter lay chiefly under the sternum and might of itself prove a danger. Accordingly, I isolated the lobe, so far as this could be done by blunt dissection, in the customary intracapsular manner. The bleeding vessels were, as usual, doubly ligated with catgut. Furthermore, in typical fashion, I tied the superior thyroid artery and vein at the upper pole, and also the superficial vessels running to the lower pole. Next, with little snippings of the scissors, I freed from the anterior and lateral surfaces of the trachea the adherent lobe, taking care to avoid dissecting too far posteriorly, for fear of injuring the recurrent nerve. Finally, the entire goitre was bound only in the angle between the trachea and esophagus, just where the recurrent nerve and the inferior thyroid artery lie buried. This adherent part at the hilus of the gland I treated as if it were a short, thick ovarian pedicle. While an assistant made pressure with the fingers on the vessels entering the hilus, I split the 'pedicle' longitudinally with the blunt scissors into several portions, clamped each portion with a hemostatic forceps and tied with catgut in the line of the clamp-made furrows. Only now did I proceed to cut away the goitre-mass which, in this manner, had been isolated. The pinces hémostatiques crushed out, in line with their blades, almost the entire parenchyma of the gland, so that in the ligature-furrow little remained but the connective-tissue stroma and the blood vessels. . . . .

"The remaining stump of the gland, contracted to a nodule the size of a chestnut, rested in the angle between trachea and esophagus. Neither the inferior thyroid artery nor the recurrent nerve was seen."*

Mikulicz calls this procedure a resection, to distinguish it from the typical extirpation of one or both lobes.

In the manner described he operated upon seven additional cases (Nos. 16, 19, 20, 21, 23, 24 and 25).

* "The application of ligatures en masse to the 'base' of the goitre prior to its ablation was made by operators as early as the end of the last and beginning of the present century, as is related in the *Operationslehre* of Günther and the *Operative surgery* of Dieffenbach."

Upon four of these, just as in the first case, a lobectomy having been done on one side in the typical Billroth manner, it was found necessary to remove the greater part of (viz., to resect) the second lobe. In two cases resection of one lobe was done for the removal of a circumscribed nodule, the other lobe remaining untouched. In only one case (No. 23) were both lobes resected.

"It is noteworthy that in case 23, already several times referred to, the symptoms of Basedow's disease rapidly improved after the resection—a result which Tillaux and Rehn had already observed."

Case 23: Peasant woman, *æt.* 35. Goitre, the size of two fists, involving the entire gland had been developing for eight years. Pronounced symptoms of Graves' disease—dyspnea, cardiac hypertrophy, tachycardia, exophthalmus. Operation June 26, 1885: Kocher's Winkelschnitt. Resection, by the Mikulicz method, of both lobes. Prompt recovery. October, 1885: Patient wrote that her voice was clear, her breathing free and that the palpitation of the heart had ceased. Only the exophthalmus was still noticeable.

Mikulicz recommended his resection method at a time when he did not believe that the thyroid gland was a vital organ and did not attribute cachexia strumipriva to the forfeiture (Ausfall) of a secretion. Indeed, he questioned the propriety of adopting this nomenclature of Kocher believing with Baumgärtner that the symptoms might most plausibly be ascribed to disturbed innervation in consequence of direct injury to or later changes in nerves in the neighborhood of the field of operation.

Kocher had suggested that deficiency of oxygen, due to atrophy and softening of the trachea, might account for the picture, not, however, discrediting the view that the thyroid's function might be to regulate the supply of blood to the brain. He did not believe that cachexia strumipriva was due to the loss of a secretion, for he wrote:

"The change in the condition of the patient cannot be explained by the elimination of the function of the thyroid"; and again: "We believe that the symptoms which condition the picture of idiocy are probably determined by the influence upon the breathing, upon the supply of oxygen, in so far, at least, as it may not be ascribed to the cutting out of that function of the thyroid gland which serves in the formation of the blood."

As to the cause of tetany Mikulicz was inclined to agree with Billroth who, in discussing Weiss's paper, had expressed himself as follows:

"I am inclined, therefore, to lay especial stress upon the division of the numerous nerves of the thyroid gland, and believe that tetany

occurs only in those individuals who are predisposed to nervous affections."

Hence, Mikulicz planned his operation of resection not with the idea of leaving to the patient a portion or portions of a vital organ. He merely knew that removal of the entire gland was likely to be followed by Kocher's cachexia strumipriva or tetany, or both. He feared, also, recurrence of the goitre and injury to the recurrent nerve, and his operative experience had taught him not only that sometimes it was imperative to excise the greater part of both lobes in order to relieve pressure upon the trachea, but also that neither cachexia strumipriva nor tetany occurred if a portion of even one lobe were left. If so much is to be gained by leaving a part of one lobe, why not leave parts of both, he undoubtedly asked himself. For cosmetic reasons, and also to protect the laryngeal and possibly other nerves, the posterior portions of the lobes would naturally have been the parts left to the patient.

It would not be especially interesting to trace further the tardy development of the operation of thyroidectomy in England, France, Italy and America. Progress in operation upon the thyroid in this country has been made chiefly since 1890 and by those who were familiar with the advanced work of the Swiss, Austrian and German surgeons—of Victor von Bruns, Billroth, Lücke, Kappeler, Kocher, Reverdin, von Gussenbauer, Wölfler, Baumgärtner, Mikulicz, von Eiselsberg, Payr, Schloffer and others.

On my return from Germany in 1881 I was impressed with the fact that our surgeons were greatly handicapped in most of their operations by lack of proper instruments, particularly of artery clamps. These were insufficient in number and faulty in design. In most of the New York hospitals the only artery clamps were of the fenestrated, mouse-toothed, spring forceps variety (Liston's and Wakley's), indeed, these were about the only ones procurable either in this country or England. In the elaborate catalogue for 1882 of S. Maw, Son and Thompson, London, no other artery forceps, torsion forceps excepted, is mentioned.

In a catalogue of Collin et Cie, Paris, undated, but evidently of about the same period, the little artery clamps of Koeberle and of Péan are the only ones figured; " pinces à artères à ressorts " are catalogued, the latter probably being the mouse-toothed forceps given in the London catalogue (Maw and Son) and quite universally employed in America until 1880 or a little later.

In Günther's *Surgery* (vol. i, Plate 5, opp. p. 36) is a remarkable lithograph (*vid.* Plate xxiv, Fig. 3) which indicates the part played by the tenaculum in hemostasis in 1859. The divided artery, open-mouthed, is hooked up on the point of the instrument, the handle of which is held in the mouth of the operator who, evidently, was short-handed. Until about 1890 the tenaculum was a favorite instrument in America for checking hemorrhage, especially with some of the senior surgeons, and until about 1880 was quite universally employed here, its only rivals being the inadequate mouse-toothed, spring forceps and the Péan or Koeberle clamps. Then almost simultaneously came the clamps of Spencer Wells * and (1879) of the writer, of which the Péan-Koeberle clamp was the prototype. The point of my clamp was snub-nosed originally, but the length and spread of the handles, the essentially new features, were the same as at present. With the development of the transfixion method with milliner's needles and the use of the fine black silk, the nose of the clamp was made finer (1889). Two or three years later it assumed its present form (Plate xxii, Fig. 5).

Rarely had I seen in our country, prior to my first visit to Europe (1879), more than one artery clamp at a time left hanging in a wound. Clamps were too few for this—four to three or even two being considered ample for an operation. Few hospitals, in New York at least, possessed as many as six artery clamps in 1880. I recall vividly an operation in Vienna performed by Mikulicz in 1879 in Billroth's clinic. Americans, newly arrived in Austria, we were greatly amused at seeing perhaps a dozen clamps (Schieber) left hanging in a wound of the neck while the operator proceeded with his dissection, and were inclined to ridicule the method as being untidy or uncouth. Slowly it dawned upon us that we in America were novices in the art as well as the science of surgery.

The artery forceps, adequate in number and design, undoubtedly played a very important rôle in the strikingly rapid progress in the art of operating made by surgeons, the world over, in the final quarter of the past century.

Retractors of proper size and form are essential, particularly when one is working through a small incision, as in thyroidectomy and in ligation of the inferior thyroid arteries. Valentine Mott used a thin

* I have been unable to ascertain the precise date of introduction of the Spencer Wells clamp.

piece of board 3 inches wide and curved spatulas in his remarkable case of ligation of the common iliac artery. Volkmann contributed the many-pronged, grab-rake-like retractors. The blades of the retractors used in the general surgical clinic of The Johns Hopkins Hospital, specially designed in 1888, are all concave * from side to side and, for the most part, convex in the long axis of the instrument. They are solid and provided either with short teeth or with a curled lip (Plate xxiii, Figs. 2, 3 and 4).

The scalpel of our clinic has a handle designed for use as a dissector. Every surgeon instinctively makes dissecting strokes with the handle of his knife, but these motions are futile and hence false unless the tip of the handle has the proper form (Plate xxiv, Figs. 2 and 3). Aneurism-needles we use much less frequently than formerly in our thyroid and other operations, for by transfixing the tissues contiguous to the vessels, or the vessels themselves when large, a single thread of fine silk gently tied suffices where, otherwise, several strands of considerably heavier silk, forcibly tied, would be required in order to guard against slipping of the ligature.

Aneurism-needles are convenient, and sometimes essential, particularly in the ligation of undivided arteries in a deep pocket. Here we use the form shown in Plate xxii, Fig. 3. A thread, knotted into a tuft at one end, is passed through the little hole at the tip of the instrument on a milliner's needle. The black tuft, pulled home either before or after the artery has been circumvected by the aneurism-needle, is easily recognizable and picked up by the assistant. The little curved needles (Plate xxii, Fig. 4) have an eye in the middle, and are flattened in order that they may be firmly clasped by the pointed artery clamp which delivers, as well as by the one which receives them. We have rarely employed this form of aneurism-needle. A simple contrivance which we frequently make use of is a threaded needle broken short and held in an artery clamp at the desired angle (Plate xxii, Fig. 5). I take pleasure in expressing my appreciation of the care given by the late Wulfing-Luer of Paris to the making of almost all of the surgical instruments originally purchased for The Johns Hopkins Hospital and designed by the author, and my thanks to his sons

*** I have heard that Sir Victor Horsley, prior to 1888, had employed, in operating upon the brain, a retractor, concave from side to side; but at the time when our instruments were designed, concave retractors were not to be found in the instrument shops of London, Paris, Hamburg or Berlin.**

for many subsequent courtesies. Our instruments, with few exceptions, were fashioned from original designs; the handles, also, had all to be made to order, for at that time (the winter of 1888 and 1889) the handles of instruments in France and England were of wood or bone or ivory—occasionally of hard rubber. In Germany, Dannenberg of Hamburg, at the suggestion of Schede and of Kümmel (originator of the inorganischer Verband), was making metal handles for many of the instruments, and Schmidt and Windler of Berlin for scalpels.

Many times during the past 20 years I have stood by the side of Professor Kocher at the operating table enjoying the rare experience of feeling in quite complete harmony with the methods of the operator, and it is a pleasure to give expression to the sense of great obligation which I feel to this gifted master of his art and science.

Professor Kocher acquired surpassing skill in the use of the "Kropfsonde" and aneurism-needle. For some 40 years they were his weapons in his battle with the veins and arteries of the neck. A surgeon employs the instruments which in his hands he finds most effective. My chief weapon against hemorrhage is the artery clamp, a finely pointed instrument which can penetrate and dissect and does not crush the tissues in unnecessary measure. There are times when some form of aneurism-needle is indispensable, as, for example, in the operation for ligation of the inferior thyroid artery through a short incision in the presence of a large goitre.

Tissues included between two ligatures are more or less tense according to the distance between the latter; on being divided these tissues become lax and thus loosen the hold of the ligature. To prevent slipping of the ligature under these circumstances, force sufficient to crush the enclosed tissues would have to be exercised; the greater the force the greater must be the strength of the ligature. Thus Professor Kocher found it necessary to use three or four strands of silk, which we should consider coarse, in tying off the blood vessels of the upper pole of a goitre, and emphasizes the necessity of using crushing force. Is it not a more rational procedure to transfix some part of the tissues to be ligated and use a fine thread for the ligature which, thanks to the transfixion, may be tied with just force enough to stop the flow of blood? The clamp should always be removed as the first turn of the knot is being drawn home; otherwise, as every surgeon knows from experience, the grip of the tie may be loosened, and the ligature, if not a transfixing one, may slip away. The surgeon who has become convinced of the importance of devitalizing tissues as little as possible will not only

employ the finest adequate silk, but will, as he ties, note the force necessary to check the hemorrhage, and use no more. By practice the operator acquires a delicacy in tying, and develops a particular sense which enables him to gauge with accuracy the amount of pull which, for example, a thread No. 00 will permit.

THE AUTHOR'S OPERATION

The window in the top operating sheet is fastened to the skin with fine stitches, two of them, exactly in the midline, serving as a guide in bringing together the lips of the wound. Formerly the midline stitches were placed as shown in Plate xv, Fig. 1, the sheet being clamped to the skin, in clumsier fashion.

A collar incision is usually made in the line of a wrinkle over the centre of the tumor, but sometimes a little nearer to the upper than the lower poles of the thyroid lobes, and occasionally just above the sternal notch, conforming exactly to the curve taken by a trial necklace. It should be carried only very slightly, if at all, upwards at the ends, because the greater the departure from the transverse to the vertical the more unsightly becomes the scar. The platysma muscle, having been divided, is dissected upwards with the skin-flap, the veins being carefully avoided (Plate xv, Fig. 2). The lower flap is not dissected free throughout its entire extent; but in the midline it is reflected low enough to expose the manubrial notch. In splitting between the sterno-hyoid muscles, veins which may cross the midline are ligated, by the transfixion method if necessary, with the finest silk. The sterno-hyoid and omo-hyoid muscles are gently raised away from the sterno-thyroid, the extent and thickness of which is noted. On retracting the muscles of the neck outwards an accessory thyroid vein (or two) is occasionally brought into view, stretching obliquely or transversely across the space to the thyroid gland. These vessels we ligate with the assistance of the broken, threaded needle (Plate xxii, Fig. 5). They should be secured at this stage of the operation, before the sterno-thyroid muscle is stripped from the gland, otherwise they may be torn and prove troublesome. When the sterno-thyroid is thin and narrow, its posterior border may be hooked up with a broad vein-retractor and pulled mesially far enough to expose the superior thyroid vessels sufficiently well; but, ordinarily, we retract this muscle outwards or split it longitudinally in line with these vessels. It is a mussy procedure to cut across and then push up and down the divided fibres of the sterno-

thyroid. The dissection is much cleaner if the muscle is split or, better, merely retracted (Plate xvi, Figs. 1 and 2).

The superior pole of the lobe can now be hooked forward with the index finger without fear of tearing a blood vessel. Two clamps are applied near this tip of the gland (Plate xvi, Fig. 2), the upper one about 1 cm. below the entrance of the vessels to the pole. The gland is cut across between these clamps to about the situation of the mesial branch of the artery, when one or two more clamps are applied and the gland is further divided to the trachea (Plate xvii, Fig. 1), which at this juncture is usually bared to the upper edge of the isthmus.*

The lobe is then rolled inwards over the trachea and the loose, extrinsic capsule divided and gently sponged back with the Breslau or "Küttner" roll.† The fine-pointed artery clamps of our clinic are then applied, as shown in Plate xvii, Fig. 2, and its insert, only in greater number. The vessels, arteries and veins are clamped well away from the parathyroids and the recurrent nerve. I have never advocated ligation of the trunk of the inferior thyroid artery.‡ The clamps being placed as depicted, the lobe is rolled outwards (Plate xviii, Fig. 1), three or four vessels of the isthmus being clamped before dividing this structure, which is usually first separated from the trachea with a long, narrow, blunt dissector and then transfixed and gently ligated.

The lobe is now resected from within outwards, just distal to the encircling clamps. In the course of this slicing off of the gland, three or four more vessels have usually to be caught (Plate xviii, Fig. 2). Their positions are fairly constant and hence they can usually be recognized and clamped before being divided.

Fine milliner's needles, armed with silk No. A, whipped along the capsule in such fashion as to be buried in the glandular tissue, occlude the vessels and thus release the clamps. If there should still be the

* The seizure of the upper pole with the artery clamps, in all cases advantageous, is especially helpful when the tip of the lobe is long and slender and extends far up and behind the trachea or esophagus and is difficult to engage with the finger. Under these conditions it may be necessary to apply, in the line of the incision through the pole, a number of clamps in pairs, the gland, as it is drawn forward by the clamps, being divided between them as each pair is placed.

† This useful little roll of tightly wound gauze was devised by the orderly of the Breslau clinic in the days of von Mikulicz.

‡ I emphasize this fact because Professor de Quervain (Surg. Gyn. and Obst., 1916, vol. xxiii, p. 402), to whom I wish to express my compliments for his polite reference to my work, has misunderstood my procedure.

least oozing from the cut surface of the gland, the stump with its capsule is transfixed here and there in mattress fashion or otherwise (Plate xix, Fig. 1). Occasionally, but very rarely, and only when it rides forward, the raw surface of the stump of the lobe is opposed to the raw surface of the isthmus (Plate xix, Fig. 1). The little stump of the superior pole is then drawn down and transfixed with a short needle * carrying a ligature of silk No. C. The transfixion is an almost indispensable procedure. As the ligatures passed in this manner cannot slip, very fine thread may be used, because only just enough force to close the vessel is required.

For subcutaneous vessels silk No. 00 is sufficiently strong. The fat is transfixed in the typical way and the hair-fine thread tied so gently that the tissues are not unnecessarily devitalized. When the tissues are ligated in this delicate manner, made possible by the transfixion, the wound is not studded with the stellar necroses which otherwise abound.

SPECIAL FEATURES OF THE OPERATION WHICH WERE MORE OR LESS NOVEL AT THE TIME OF THEIR INTRODUCTION INTO OUR CLINIC

1. Preservation of the superficial veins of the neck.

2. No muscle except the platysma is divided—not even the sterno-thyroid—except in case of large or adherent goitres.

3. The sterno-thyroid muscle is retracted outwards—occasionally split longitudinally.

4. Delivery and division of the superior pole before the remainder of the gland is dislocated.

5. Resection in place of total lobectomy in order to protect the parathyroid glands and the recurrent laryngeal nerve and to preserve a slice of thyroid in case an operation might have to be performed, possibly by another surgeon, on the opposite lobe.

6. Ultra-ligation (well beyond the origin of the parathyroid arteries) of the blood vessels, all of which are clamped before the lobe is resected.

7. Ligation of the inferior thyroid artery is not practised.

8. Closure of the wound without drainage.† This is made possible by the use of fine silk and the transfixion method for the absolute arrest of hemorrhage.

* This needle is shown in Plate xx, Fig. 1.

† I am interested to note that in 1891[147] I warned against the use of drainage tubes as follows: "It was not until the fall of 1889 that, for clean

ENUCLEATION AND RESECTION-ENUCLEATION OPERATIONS FOR ADENOMATA

The discovery by Emil Goetsch, of our surgical staff, that the parenchymal cells of active thyroid adenomata are richly studded in the cytoplasm with mitochondria approximately proportionate in numbers to the toxic activity of the new growths clarifies a problem which has long perplexed surgeons, and accentuates the necessity of searching for and removing so far as possible all the adenomatous tissue of both lobes and isthmus. We now at last know that the symptoms of hyperthyroidism present in most patients with adenoma when they present themselves for examination, and quite surely present at some period in all, are due to the hyperactivity of the epithelial cells of the adenoma and not to stimulation of the surrounding, histologically normal thyroid tissue. Adenomata may be large or small, single or multiple. They may attain great size, be pendulous and extend to or below the umbilicus, or so small as to be invisible to the naked eye. The entire thyroid gland may be so studded with small adenomata, microscopic or macroscopic, that their removal by enucleation is not feasible and that only resection of the greater part of both lobes avails. In the case of such glands, which might be termed conglomerate, some of the adenomatous tissue must be left in the slice from each lobe which should always be preserved to the patient. Usually the adenomatous nodules, however small, are more or less definitely circumscribed and bounded by some sort of connective-tissue capsule; but we have occasionally found widely disseminated adenomatous-like non-encapsulated areas in the otherwise normal thyroid gland of thyreo-toxic patients.

On Plate xxi, Figs. 1 and 2, are pictured two stages of the operation which we usually perform for the removal of the adenomata. The lower clamp is placed as near as possible to the adenoma in order that the tumor may be made tense by its application. An incision through the glandular tissue between the clamps is made close to the lower one, on the release of which the adenoma partly extrudes itself through and thus defines its enveloping capsule. Before incising between the two

wounds, we discarded, absolutely, drainage in all of its forms. Since September, 1890, we have closed, without drainage, *all* wounds—the suppurating as well as the clean wounds." In those days all infected wounds were thoroughly cleansed by excision and prolonged disinfection just as in our blood-clot cases, and closed loosely, tension being studiously avoided.

clamps figured in the illustration, other clamps are placed on the visible vessels as in the operation for the excision of a lobe, but along higher meridians. By this method both lobes can be freely explored, each by a vertical incision, and the adenomata enucleated. Should a resection-enucleation be indicated the clamps may be transferred to a deeper meridian.

The operation of enucleation was first defined and recommended by Luigi Porta,[181] although probably performed earlier by Heiser and others. It is discussed instructively by Kocher[183] who had a method of his own which is depicted in the several editions of his *Chirurgische Operationslehre*. The operation of enucleation as practised by Socin, who revived it and popularized it, is minutely described by Keser,[184] previously his assistant in Basel.

In the story of the development of the operation for goitre the essential history of surgery is comprised. The problem had been a pressing one for hundreds of years, and not only in countries where the majority of the population was affected with the disease. It could not be solved until surgeons had become proficient in the art of dealing with blood vessels. This art could not be acquired except by experience in operating. The experience could not be gained until anesthesia was discovered. With the introduction of anesthesia the number and magnitude of operations promptly increased. The knowledge acquired from the new opportunities soon manifested the need of better methods for controlling hemorrhage, and primitive forms of artery forceps were devised. From these, after a time, the artery clamp was evolved. With the rapidly increasing number of patients and the crowding of hospitals, sepsis reared its head in form so dreadful that hospitals had to be destroyed and operating had to be discontinued, only desperate cases being brought under the knife, for a simple incision was quite surely to be followed by pyemia, septicemia, hospital gangrene. With the introduction of Listerism came the daybreak of modern surgery which had dawned with the advent of anesthesia. And now in the few years since the discovery of anesthetics, in the brief span of one life, surgery, so it seems, has marched from the beginning to near the end of its great era—the great era of operative development. Fortunate, indeed, are those who have labored throughout this stage of its long journey. More privileged still, we trust, may be the progressive surgeons to come who soon must seek fresh pastures and new friends.

TABLE I.—FRANCE

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
1	Desault, P. J. Giraud, Sur l'extirpation d'une partie considérable de la glande thyroïde. Jour. de chir., Paris, 1792, iii, 3.	F. 27 yrs.	Tumor, 2 inches in diameter, of right side and center of trachea, extending under sternomastoid. Duration, seven years.	Slight dysphagia. Deformity, for the relief of which the operation was performed.	May, 1791. Excision of right lobe masterfully performed. The superior and inferior thyroid arteries and other vessels ligated as encountered in course of the dissection.	Recovery.	Full account given in our text. Probably the first instance of isolation and ligation of the superior and inferior thyroid arteries in the course of excision of a goitre. *The tumor was carefully separated from the trachea.* The ligation of a "pedicle" or of tissues *en masse* was not resorted to.
2	Bonnet, of Clermont-Ferrand. Brun, Jean, Dissertation sur le goitre. Paris, 1815, p. 16.	.....	.....	.....	Date not given. Excision of thyroid gland.	† Death from hemorrhage.	Brun writes: "Bonnet, famous surgeon of Clermont-Ferrand, also practised this operation, but he was not so successful as Dr. Dupuytren; his patient perished, the victim of hemorrhage."
3	Desault, P. J. Rullier, Dict. d. sci. méd., Paris, 1817, xviii, 556.	F.	.....	.....	Date not given. As soon as dissection of tumor was begun blood flowed with such appalling violence that the operator was "obliged to give up the pursuit of his object." He decided to ligate the portion of the thyroid which had been incised, by means of many threads passed into its depths, but spasms supervened and patient died.	† Died on operating table.	*Vid.* text for Rullier's comments.
4	Dupuytren, G. *Ibid.*, p. 557.	F. 28 yrs.	Huge tumor extending from chin to sternum and from one maxillary angle to the other. Duration eight years.	Dyspnea; dysphagia; flushing face; dazzling; vertigo.	Jan., 1808. Excision of entire gland in relatively bloodless manner. All vessels were doubly ligated before division.	† Died 35 hours post operation from shock.	Full history in our text. Apparently a faultless operation. Interesting to note that Dupuytren always applied the first of the two ligatures on the cerebral side of the artery in order that the second ligature might be tied without causing pain.
5	Operator Unknown. Case communicated to Rullier by "Professor Percy." *Ibid.*, p. 564.	M. Le Marquis de A.	Large sarcomatous goitre.	No symptoms. Deformity.	No details given.	† Death from hemorrhage.	Operation advised by Desault, but disapproved by the eminent Louis and Professor Percy. Rullier comments: "The imprudent operator saw the patient die instantly of a frightful hemorrhage, and this beneath his eyes, between his hands, and under the knife which should have been the instrument for cure."
6	Dupuytren, G. v. Froriep, L. F., Ungeheuer grosse, faserig-zellige Geschwulst an der linken Seite der glandula thyreoidea exstirpirt, mit unglücklichem Ausgange. Notizen aus dem Gebiete der Natur- und Heilkunde, Erfurt, 1831, xxix, 141.	F. 12 yrs.	Tumor, "size of her head, occupying the whole left side of the neck." Duration since infancy.	No mention made of symptoms.	Nov. 22 (1829?). Tumor was found to have broad base; was not pedunculated as had been premised. Pedicle was constricted by three ligatures of thread. These were replaced by a metal ligature after patient was put to bed. Tumor was not removed.	† Died about 40 hours post operation.	Froriep acknowledges his indebtedness to Dr. Clémot, assistant at the operation, for the facts. Hemorrhage from many veins was controlled temporarily by finger pressure. Patient was in syncope at end of operation. Obstinate vomiting set in the day following the operation. Finally, convulsions and death.

TABLE I.—FRANCE.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
7	Nélaton. Goitre, Bull. de la soc. anat. de Paris, 1835, s. 3, t, 100.	M. 20 yrs.	"The tumor was as large as a fist."	No account of symptoms.	No account of operation given.	Not stated.	The specimen was presented to the Soc. anat. "It presented a varied aspect. At certain points it was osseous, in others fibrous, and besides it had the aspect of lymphatic ganglia hypertrophied and indurated."
8	Blandin. Ferrus, Dict. de méd. ou répertoire gén. d. sci. méd., 1836, 2e éd., xiv, 181.	.....	.....	.....	.....	†	Ferrus, after giving an account of Dupuytren's operation, says: "Mr. Blandin had a similar unsuccessful case." There are no further details.
9	Roux. Rufz, De l'extirpation d'un goitre. Arch. gén. d. méd., Paris, 1836, s. 2, x, 25.	M. 22 yrs.	Large nodular goitre in center of neck.	.....	March 26, 1835. Total excision of the gland. The goitre was removed in three parts. About 50 ligatures applied. Estimated loss of blood was 1½ pounds. Duration of operation, 70 minutes.	† Died a few hours post operation.	Notwithstanding the great loss of blood, the pallor and collapse of the patient, six ounces of blood were withdrawn from a vein a few hours after the operation. Death followed three hours thereafter.
10	Voisin, P. Chirurgien de la maison centrale de détention de Limoges. Ablation d'une tumeur située dans la région thyroïdienne; guérison. Gaz. méd. de Paris, 1836, s. 2, iv, 372.	F. 36 yrs.	Large tumor of "anterior and inferior part of neck." Duration 21 years.	.....	Oct. 19 (1835?). Excision, probably of left lobe. Six to eight ligatures of veins, three of arteries, all tied with only one knot. Bloody operation. Duration half an hour.	Recovery.	Rather slovenly and rapid operation. Operator states that he was unable to find any trace of a right lobe. Advocates leaving blood in the wound to fill a dead space and to serve in the work of cicatrization. Thus, like John Hunter, he had observed the organization of the bloodclot. Makes interesting comments on the qualities of the blood.
11	Bach. Agrégé médecin en chef-adjoint à l'hôpital civil de Strasbourg. Hirtz, L., Goître volumineux; ligature; guérison. Gaz. méd. de Paris, 1841, s. 2, ix, 9.	M. 30 yrs.	Goître, right side, "10 cm. in all diameters." Duration 20 years.	Very slight interference with respiration and deglutition. Voice a little raucous.	July 25, 1840. Tumor enucleated and pedicle ligated; the ligatures being passed through beads and a silver cannula and fastened to a transverse bar in such manner that they could be tightened at pleasure. The bloodless operation was performed in 10 minutes.	Recovery.	The ligature was drawn tighter from time to time, each manœuvre of this kind being followed by increased interference with respiration and swallowing. The tumor sloughed away.
12	*Idem.* Hirtz, L., Goître; ligature; guérison. *Ibid.*	M. 27 yrs.	Cystic goitre, size of an orange, in midline. Slight enlargement of lateral lobes. Duration three years.	Roughened voice; difficult respiration.	1840 (September ?). Draw-knot ligature about thick pedicle. Ligature was gradually tightened and tumor ablated fourth day post operation.	Recovery.	
13	Rigal, R., de Gaillac. Sur le traitement chirurgical du goître par la ligature sous-cutanée. Bull. gén. de thérap., méd. et chir., Paris, 1841, xxi, 224. Case, p. 225.	F. 19 yrs.	Goître. Size not stated.	Dyspnea; vertigo; nightmares.	Aug. 8, 1841. Three separate subcutaneous ligatures en masse.	Recovery. September 6, 1841, only a trace of the goitre.	"It was decided to apply a ligature en masse, but in three distinct parts, and not wishing to sacrifice the skin, we took care to make the ligature subcutaneous."

TABLE I.—FRANCE.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
14	Ballard. Goitre volumineux guéri par la ligature sous-cutanée. Original in Bull. soc. de méd. de Bésançon, 1845 (not in Surgeon General's Library). Abst. in Arch. gén. de méd., Paris, 1846, s. 4, xi, 222.	F. 19 yrs.	"Voluminous goitre." Duration eight years.	Dyspnea; suffocation.	Aug. 8, 1845. Subcutaneous ligatures passed through beads drawn so as to strongly compress the goitre.	Recovery. Infection and "considerable reaction."	Original paper not obtainable. Meagre abstract. Sept. 30, 1845. "The cure was complete."
15	Roux, Ph. J. Petit, Goitre. Opération suivie de mort. Bull. soc. anat., Paris, 1848, xxiii, 205.	F. 23 yrs.	Moderately large colloid nodular goitre. Right lobe considerably larger than left. Duration five years.	No symptoms noted.	Nov. 20, 1847. Excision; probably of entire gland. Veins, very large, were ligated and then cut. Some vessels were cut first and tied afterwards; hence, the hemorrhage was probably considerable.	† Died on second day post operation.	The left recurrent nerve was cut.
16	Bégin, Military Hospital, Strasbourg. Tumeur du corps thyroïde. Bull. de l'acad. nat. de méd., Paris, 1849-50, xv, 1110. Case, p. 1111.	M. "Young soldier."	Two cysts, each the size of a pigeon's egg, in midline. The lower tumor plunged behind the sternum.	.....	Date not given. Both tumors were easily removed there being only light adhesions—a fine pedicle connected the two. The cysts contained "serous and cretaceous matter."	"Recovery was difficult and tardy."	While making toilet of wound the thyroid gland was observed to swell remarkably. There was no hemorrhage nor extravasation. The patient, menaced with suffocation and congestion, "was bled copiously."
17	Roux, Ph. J. Observation d'une extirpation de bronchocèle faite avec succès. Bull. de l'acad. nat. de méd., Paris, 1849-50, xv, 1106. (This case is also given by Michel, Obs. II.)	M.	Hard nodular goitre, size of fist, situated probably in the left lobe. Duration 15 years.	.....	July 10, 1850. No anesthetic. Extirpation "without great loss of blood." Vessels cut and then ligated. Some ligated before being divided. Wound stuffed with wads of lint.	Recovery.	August 31, 1850. Paralysis of recurrent nerve. Tumor consisted of numerous cysts with serous, cretaceous and stony contents. Presumably adenomata.
18	Sédillot, of Strasbourg. Extirpation du goitre. Bull. de l'acad. nat. de méd., Paris, 1849-50, xv, 1132.		"Enormous thyroid tumor."	No account of symptoms.	Date not given. Tumor removed. A ligature was placed on the last insertions of the morbid mass.	Recovery.	Tumor "the size of an infant's head." It "hung over the chest." Details of operation not given. Very brief report of this and the two following operations.
19	*Idem.* Bull. de l'acad. nat. de méd., Paris, 1849-50, xv, 1132.		"Enormous thyroid tumor."	No account of symptoms.	Date not given. Tumor removed. A ligature was placed on the last insertions of the morbid mass.	Recovery.	
20	*Idem.* Military hospital. Bull. d. l'acad. nat. de méd., Paris, 1849-50, xv, 1132.		"Enormous thyroid tumor."	No account of symptoms.	Date not given. Tumor removed. A ligature was placed on the last insertions of the morbid mass.	Recovery.	The operator's procedure was "to place successively on these venous plexuses two ligatures, one on the side of the tumor and the other on the opposite side, in order to divide these vessels without hemorrhage."
21	Cabaret (de St. Malo). Extirpation d'un goitre. Gaz. méd. de Paris, 1850, s. 3, v, 710. (Presented by Dr. Velpeau. Acad. de méd., séance de Septembre 24, 1850.)	M. 67 yrs.	Goitre, midline, size of an ostrich's egg. Duration about one year.	Shortness of breath on exertion; slightly impeded deglutition; abnormal voice.	May 28, 1850. Sitting posture. Excision of both lobes. Most vessels were cut first, then tied or twisted, but only the central ends. Vessels believed to be the superior thyroid arteries were divided between two ligatures. "Scarcely 500 gm. of blood were lost."	Recovery.	

TABLE I.—FRANCE.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
22	Alquié, Professor. Ligature des artères thyroïdiennes pour remédier à la suffocation causée par le goitre. Annales cliniques de Montpellier, 1854, ii, 222. Also reported by Dr. Barbin, Thèse, Montpellier, 1854, p. 26.	F. 25 yrs.	"Enormous goitre, divided into three perfectly distinct lobes." "Careful and repeated examination failed to reveal the inferior thyroid arteries."	"Orthopnea; difficulty in speaking; disturbance of cerebral circulation; troubled sleep; disturbed digestion; voice peculiar; pulse regular."	Op. I.—April 10, 1854. Ether. Ligation of superior thyroid arteries. Op. II.—Date not given. "Three large arteries were found in contact at the same point, viz., behind the clavicular attachment of the sterno-mastoid. Unable to make a choice among these enormous vessels, the operator contented himself with ligating an ascending branch of the inferior thyroid artery."	Recovery.	Thirteen days post first operation, circumference of tumor 8 cm. less. Cerebral circulation re-established. Respiration easy. Sleeps well. Speech normal. "The patient . . . . left, full of gratitude to a surgeon who, had he not been conscientious, might have performed another operation than that of ligating the thyroid arteries, viz., extirpation, to which this woman would readily have consented."
23	Dunglas, in Lima. Observation de goitre enkysté. Extirpation du kyste. Guérison. Gaz. méd., Paris, 1856, s. 3, xi, 129.	F. 22 to 24 yrs.	"Goitre, the size of her face." A single cyst. Duration "some years."	.....	1831. Cyst incised and thereupon enucleated. No blood vessels divided and there was "not the least hemorrhage."	Recovery.	Patient complained that her tongue was being torn out when traction was made on the tumor whose only adhesions were "at the base of the larynx." Probably a cyst of the thyreo-glossal duct.
24	Chassaignac. Foucart, A., Goitre kystique latéral; sblation heureuse par écrasement linéaire. La France méd. et pharmaceutique, Paris, 1860, vii, 284.	F. 29 yrs.	Cystic plunging goitre, size of large pigeon's egg, near the insertion of left sterno-mastoid. Duration one year.	Constant dyspnea, frequent cough and occasional dysphagia; severe pains radiating to left shoulder and arm; occasional numbness of arm.	Oct. 17, 1859. Dissected free with scissors, sac accidentally pierced, collapsed completely. Écraseur chain applied to pedicle caused convulsions; reapplication, later, again caused convulsions. Ablation "finally accomplished."	Nov. 22, 1859. Recovery. Rather stormy convalescence.	I saw, last year, a patient with Graves' disease who requested operation on the goitre in order to obtain relief from severe pains in shoulder, arm, forearm, etc. We found a cervical rib. She refused operation on either rib or thyroid when told the cause of her pains.
25	Gosselin, Hôpital Beaujon, Paris. Goitre suffocant cancéreux à forme galopante; asphyxie. Tentative infructueuse de trachéotomie. Bull. de la soc. chir., Paris (for the year 1861), 1862, s. 2, ii, 163.	F. 22 yrs.	"The tumor on the right was a continuation of the isthmus consisting of several unequal masses, some of which extended beneath the right sterno-mastoid. The portion of the tumor on the left was formed of the left lobe of the thyroid, enlarged, but whose structure did not appear to be altered." Duration eight or ten years.	Suffocation; dysphagia.	Exploratory puncture, March 1, 1861. Op. I.—March 2, 1861. Successive subcutaneous sections of the two fasciæ of the sterno-mastoid at its insertion at the clavicle. This was done to relieve suffocation, but had no effect. Op. II.—March 4, 1861. Incision in the midline and on the right and left sides to liberate the tumor. A crucial incision was made on the middle of the tumor which was cauterized with nitrate and "acide de mercure." A quadruple thread was passed transversely through the body of the tumor, as much to produce suppuration as to draw it outside. Op. III.—March 4, 1861. Tracheotomy attempted, but not accomplished.	† Died March 4, 1861. Asphyxia.	Microscopic examination of the tumor and ganglia, made by M. Sée, reveals the existence of cancerous cells.

TABLE I.—FRANCE.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
26	Boeckel. Pesme, A., De l'extirpation du goître. Thèse, Strasbourg, 1867, p. 43. Obs. I.—Extirpation du lobe gauche de la thyroïde par l'anse coupante de Middeldorph. Mort.	F. 19 yrs.	Large adenoma of left lobe. Duration eight years.	Dyspnea.	Op. I.—Oct. 1, 1867. Gland punctured. Op. II.—Oct. 7, 1867. Enucleation. Ligation of left superior and inferior thyroid arteries.	† Died October 10, 1867. Sepsis.	Autopsy: "The wound and parts present a gangrenous aspect." Mediastinal infection.
27	Michel (Professor in Nancy). De l'extirpation complète de la glande thyroïde dans les cas de goîtres suffocants, cystiques ou parenchymateux (opération suivie de succès). Gaz. hebd. de méd. et de chir., Paris, 1873, s. 2, x, 699, 718.	F. 24 yrs.	"Parenchymatous" goitre, involving both lobes, but greatest development in midline and left side. Duration 15 years.	Dysphagia; dyspnea; muffled voice; headache; giddiness.	Nov. 23, 1872. Excision of entire gland. Operation methodically performed. All arteries tied before division. "Patient had not lost 150 gm. of blood." Time, one hour.	Recovery.	*Vid.* text for abstract of Michel's paper. Goitre operations had been abandoned for 20 years prior to this. He may be said to have revived the operation for France. Michel adopted the novel procedure of permitting vessels doubly ligated to remain undivided until a later stage of the operation.
28	*Idem.* du Terrail Couvat, Ch. Contribution à la thérapeutique chirurgicale de goître cystique. Nouveau procédé opératoire. Thèse, Nancy, 1876, p. 40.	F. 16 yrs.	Cyst of thyroid, size of two fists.	.....	April 28, 1875. A three-act operation: (1) Isolation of greater part of cyst; (2) puncture and evacuation of fluid; (3) cauterization of the sac. Procedure of Michel.	Recovery, but with a slight distention of the neck.	The procedure of Michel is called "Procédé opératoire, procédé mixte (dissection-cautérization)." There were two slight post-operative hemorrhages. Noteworthy, that having excised the entire gland three years previously (case No. 27) he should have resorted to puncture and cauterization.
29	Gross (chef de clin. chir., fac. de méd., Nancy). *Ibid.*, p. 41.	M. 21 yrs.	Cyst, size of large orange, to the left of median line. Duration three years.	Slight respiratory disturbance.	May 31, 1875. Isolation, puncture, cauterization ("dissection-cautérization"). Procedure of Michel.	Recovery.	
30	Michel. *Ibid.*, p. 45.	F.	Cystic tumor, size of fist, pressing on trachea. Duration about two years.	Dyspnea.	Date not given. Isolation, puncture, cauterization. Procedure of Michel.	Recovery.	
31	Boeckel, Eugène, of Strasbourg. Du goître rétropharyngien et de son extirpation. Bull. et mém. soc. chir., Paris, 1879, n. s., v, 303.	F. 25 yrs.	Cystic tumor, size of an apple, on right side of neck. A second cystic tumor on the right side was retro-pharyngeal. Duration about three years.	Dysphagia. Respiration free.	Op. I.—Dec. 7, 1878. "Exploratory puncture." Op. II.—Dec. 9, 1878. Tumor on right side of neck punctured and sac excised; the retropharyngeal cyst accidentally ruptured and removed.	Recovery.	Walls of cyst examined by Recklinghausen, who found them composed of thyroid tissue. Boeckel refers to Storck's three cases of "hématomes rétro-pharyngiens" (Wien. med. Woch., 1878, Nr. 46, 1215) believing them to be the same as his.
32	Péan, Hôpital St. Louis. Brochin, Deux cas d'ablation de tumeurs thyroïdiennes. Case 1.—Goître solide; ablation; abscès des médiastins; péricardite hémorrhagique; mort. Gaz. des hôp., Paris, 1880, liii, 193.	M. 24 yrs.	Solid goitre of right lobe, size of fetus head. Duration 10 years.	Dyspnea; suffocation.	Oct. 19, 1878. Enucleation. Vessels clamped before division—35 clamps employed; 12 of these were removed the following day. Alcohol dressing.	† Died Nov. 2, 1878.	Oct. 25, 1878. Mediastinal abscess; pericardial effusion; double pleurisy. The tumor was evidently an adenoma. The number of clamps left hanging in the wound is not stated.

TABLE I.—FRANCE.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
33	*Idem.* Brochin, Case 2.—Kyste sanguin du corps thyroïde; ablation de la glande thyroïde, guérison. *Ibid.*, p. 195.	M. 19 yrs.	Tumor, size of large orange, in midline, composed of numerous cysts filled with blood-stained fluid containing cholesterin. Duration five years.	Dysphagia; "sense of constriction of larynx."	July 19, 1879. Enucleation—only five clamps employed, all removed—wound closed with metallic sutures; collodion dressing.	Recovery.	July 20. Alcohol and carbolic dressing. July 26. Small abscess opened. The walls of the tumor were 1 cm. thick.
34	Communicated by Durdos. Boursier, A., L'intervention chirurgicale dans les tumeurs du corps thyroïde. Obs. I.—Kyste colloïde de la glande thyroïde, rupture vasculaire, collection sanguine. Ponction. Guérison. Thèse, Paris, 1880, p. 170.	M. 37 yrs.	Colloid cyst in midline. Circumference of neck 42 cm. Duration 12 years.	Slight dyspnea; slight dysphagia; pain.	Cyst punctured three times—Aug. 17, 1879, Sept. 15, 1879 and Sept. 19, 1879.	Recovery.	After eight months there was only a small tumor, the size of a pigeon's egg, situated on the median line above the sternal notch. The right lobe of the thyroid is larger than normal.
35	Ollier. Boursier, A., Obs. II.—Goitre kystique ayant donné lieu à la triade du goitre exophthalmique. Opération par les caustiques. Guérison de tous les symptômes. *Ibid.*, p. 172.	F. 21 yrs.	"Cystic goitre," size of a turkey's egg. Duration three years.	Dyspnea; palpitation; insomnia; loss of flesh. Pulse 160. Eyes bulging. Menstruation irregular.	June 23, 1877. Incision of tumor, cauterization "pâte Canquoin." July 1. Second cauterization and cyst opened. July 18. Injection with tincture iodine.	Recovery.	Evidently an active adenoma causing severe symptoms of hyperthyroidism. Designated Basedow's disease by Ollier. May, 1879. A little exophthalmus. Pulse 80.
36	Le Fort. Boursier, A., Obs. IV.—Extirpation d'un goitre colloïde. *Ibid.*, p. 177.	F. 20 to 24 yrs.	Large colloid goitre; right lobe larger than the left.	No functional disturbance.	April 18, 1877. Excision of right lobe. Division of all vessels between two ligatures. Lister dressing.	"Recovery complete and rapid."	"The whole lobe surrounded by the capsule was easily removed."
37	Trélat. Boursier, A., Obs. VI.—Extirpation d'un goitre cancéreux. Mort. *Ibid.*, p. 181.	M. 37 yrs.	Large "cancerous goitre," size of "fetal head at term," occupying the whole right side of the neck. Left lobe normal. Tumor size of hazel-nut for nine years, then very rapid growth during the past year.	Headaches; shooting pains; flushing; vertigo; dazzling; cold sweats; noises in the ears; dyspnea; voice raucous, bitonal; dysphagia; great loss of weight. Pulse 100.	Feb. 8, 1880. Exploratory puncture negative. Feb. 12, 1880. Excision of the tumor readily accomplished and with little loss of blood. Asphyxia necessitated tracheotomy.	† Died 2½ days post operation.	Autopsy: Besides the tracheotomy wound there was another opening in the trachea on the right. A little fluid in left pleural cavity; great congestion of both lungs.
38	Monod. Monod and Terrillon, Opérations de goitre. Obs. I. Bull. et mém. soc. chir., Paris., 1880, n. s., vi, 643.	F. 41 yrs.	Moderately large goitre, chiefly of right lobe. Duration 33 years.	Severe attacks of suffocation; shooting pains; voice feeble and shrill.	Tumor punctured in 1863, 1866, 1880; dark or bloody fluid withdrawn. Oct. 29, 1880. Excision of tumor of right lobe, a small nodule from isthmus, and still another. Considerable bleeding. Lister dressing.	Recovery.	

TABLE I.—FRANCE.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
39	Terrillon. Monod and Terrillon, Obs. II.—Goître. Hypertrophie du lobe droit du corps thyroïde. Dyspnée. Raucité de la voix. Accès de suffocation. Extirpation. Guérison. *Ibid.*, p. 646.	F. 24 yrs.	Goitre, size of two fists, of right lobe. Duration four years.	Dyspnea; suffocation; raucous voice.	Date not given. Carbolic spray. Excision of right lobe. Division of vessels between catgut and silk ligatures. The isthmus was also divided between two ligatures. Duration 2½ hours.	Recovery.	"I did not hesitate to propose operation to the patient because inspired by the confidence given me by the present means of controlling hemorrhage and by the method of Lister." "The tumor was evidently a very vascular parenchymatous goitre." Probably an adenoma.
40	Boeckel, J. Thyroïdectomie pour un goître suffocant. Guérison par première intention. Mém. soc. de méd., Strasbourg (1879-80), 1881, xvii, 129.	F. 47 yrs.	Plunging goitre of the left lobe of the thyroid gland, measuring 8 cm. longitudinally by 7½ cm. transversely. Duration 10 years.	Attacks of suffocation; cyanosis of lips; face pale; pronounced exophthalmus.	July 20, 1880. Enucleation of tumor. The two thyroid arteries were ligated and divided. Antiseptic precaution. Vapor spray. Lister dressing.	Recovery.	Collar incision. The first mention of the horizontal incision that I have noted (W.S.H.). Anticipated Kocher by many years.
41	Tillaux. Thyroïdectomie pour un goître exophthalmique. Guérison. Bull. acad. de méd., Paris, 1880, s. 2, ix, 401. Reported also by Benard, II. Obs. I.—Thèse, 1882, p. 27.	F. 29 yrs.	Exophthalmic goitre; right lobe the larger. Pathological note: Somewhere in the gland a "cystic sac filled with blackish congested blood" was found. Duration four years.	Marked bruit in vessels of neck; heart enlarged; dyspnea; suffocation; dysphagia; palpitation; pallor and flushing; melancholy; nervousness; irritability; frequent cutaneous eruptions. "No marked exophthalmus." Pulse 90-100.	Jan. 28, 1880. Chloroform. Pulse 140. L-shaped incision, finally converted into rectangular U. Excision of entire thyroid. Rather irregular and bloody performance, terminating with the ligation on each side of the "pedicle." Deschamps' or Cooper's needles used for most of the 40-odd ligations.	Recovery.	Carbolic spray and Lister dressing employed. Post operation: "Disappearance of ocular troubles, suffocation, and palpitation." March 27, 1880, pulse 80-88. One of the earliest thyroidectomies for Graves' disease. (*Vid.* Ollier's case of adenoma with hyperthyroidism.)
42	Richelot, L. G. Thyroïdectomie. Bull. et mém. soc. chir., Paris, 1881, n. s., vii, 817. Union méd., Paris, 1885, s. 3, xxxix, 193, 205. Case was first published in L'union méd., Paris, 1881, s. 3, xxxii, 997. Communicated by Terrillon.	F. 25 yrs.	Thyroid gland enlarged to one-half size of adult fist. Right lobe larger than left; "middle lobe very hard." Duration 14 years. Induration of isthmus and left lobe due probably to the numerous treatments and infections.	Dyspnea; dysphagia; "disturbance of cerebral circulation"; voice very weak; metrorrhagia.	Iodine and caustic treatments and punctures at intervals; infections. Sept. 11, 1880. Complete excision of thyroid gland by "curved incision from one carotid to the other." Ligation of the four thyroid arteries. "The operation being finished, catgut ligatures were substituted for most of the silk ligatures." Duration two hours.	Recovery.	Second menton of collar incision (*vid.* J. Boeckel). Immediately post operation complete aphonia. Laryngoscopic examination: Absolute immobility of both vocal cords. After three months some movement of the vocal cords. Four months post operation: Patient speaks without difficulty, voice, though weak, more sonorous than before operation. The operation, well performed, must have been difficult on account of the previous treatments and infections.
43	Lebovicz, of Saloniki. Extirpation des goîtres. Case I.—Sarcome kystique du corps thyroïde; extirpation; guérison. Gaz. hebd., Paris, 1881, s. 2, xviii, 740.	F. 42 yrs.	"Tumor, size of man's fist, on right side of neck." Duration 17 years.	Dyspnea; dysphagia.	Nov. 21, 1880. Incision and evacuation of cyst. Contents purulent. Wall of sac excised. Sterno-mastoid divided.	Recovery.	"Rigorously applied antiseptic treatment." Very brief report.

TABLE I.—FRANCE.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
44	*Idem.* Case II.—Enchondrome du corps thyroïde; extirpation; mort au 6me jour.	M. 46 yrs.	"Enormous tumor of front of neck." Duration 26 years. Rapid growth in last two years.	Voice raucous; headache; deafness; face pale; suffocation.	Date not given. "Extirpation." No details—apparently a simple operation; only small vessels encountered.	† Died on the sixth day.	Tumor found to be multilocular. Death sudden, "without apparent cause." Brief report. Autopsy not permitted by the Turks.
45	Périer. Extirpation du corps thyroïde. Guérison. Bull. et mém. soc. chir., Paris, 1881, n. s., vii, 564.	M. 23 yrs.	"Hard tumor of right lobe and isthmus, size of an orange." Duration 13 years.	"Neither pulsation nor bruit" in tumor. No mention of symptoms.	May 27, 1880. Antiseptic precautions. Excision of tumor (isthmus and right lobe). Time 50 minutes. The left lobe appeared to be normal and was not removed.	Recovery.	"The tumor weighed 130 gm., and had the size and form of a breast and also its consistency, except for some disseminated calcified nuclei." Probably an adenoma. Brief report.
46	Bouilly. Goitre hypertrophique simple. Thyroïdectomie; médiastinite aiguë infectieuse; mort rapide. Bull. et mém. soc. chir., Paris, 1882, n. s., viii, 293.	F. 23 yrs.	Ovoid tumor covering the trachea from the larynx to sternum, size of an orange. Duration about five years.	Painful prickling in tumor; dyspnea; attacks of suffocation. "Neither bruit, pulsation nor exophthalmus."	Oct. 22, 1881. U-incision. Extirpation of tumor weighing 145 gm. "Finally, the lateral pedicles were cut between two strong catgut ligatures."	† Died Oct. 25, 1881. Acute infection of mediastnum.	Histologically the tumor "is constituted by simple hypertrophy and proliferation of the vesicules of the gland without predominance of any normal or pathological element."
47	Tillaux, Chirurgien de l'Hôpital Beaujon. Benard, H., Contribution à l'étude du goitre exophthalmique. Thèse, Paris, 1882. Obs. II.—Sarcome du corps thyroïde ayant donné lieu à tous les symptômes du goitre exophthalmique. Ablation de la tumeur. Guérison de tous les accidents. p. 36.	M. 33 yrs.	"Rounded tumor" of left lobe, which at operation was found to extend below the sternum. Thyroid cartilage displaced to right. Duration one year.	Suffocation; palpitation; dysphagia; raucous cough; sclera visible around cornea; sense of tension in eyes; diplopia for distant objects. Patient very irritable and easily agitated. No bruit in tumor. Pulse 80, but easily accelerated.	May 18, 1881. Chloroform anesthesia begun, but patient became so cyanosed that operation was not undertaken. May 21, 1881. Operation under large doses of chloral and subcutaneous injections of morphia. Lister technique. Rectangular U-shaped incision, cutaneous flap dissected with the fingers. Tumor ruptured in course of operation and friable, granular masses escaped, leaving little but the capsule for removal. Right lobe and isthmus "unaltered." At bottom of cul-de-sac in mediastinum the left innominate vein "of enormous size was plainly visible."	Recovery. July ?, 1881. Exophthalmus and all the other symptoms of hyperthyroidism had vanished. Died about two months post operation. No post-mortem note.	Diagnosis before operation: "Exophthalmic goitre as plain as possible." Post-operation note: "Lungs probably seat of generalized cancer, from which patient will soon succumb." "Tumor found on careful histologic examination to be sarcoma." As the toxic symptoms could not have been caused by a sarcoma or relieved by its removal, we may assume either that the tumor was an adenoma or possibly carcinoma, or that the gland was hyperplastic and in part, at least, removed.
48	Tillaux. Goitre kystique volumineux; ablation; guérison. Bull. acad. de méd., Paris, 1882, s. 2, xi, 1445.	M. 25 yrs.	"Cystic goitre, size of small ostrich egg, occupying the whole extent of the neck and plunging into the mediastinum." The tumor was "very hard, almost osseous at some points. . . . fibro-cartilaginous at others." Thyroid cartilage dislocated 3 cm. to left. Greatest circumference is 46 cm. Duration eight years.	Voice slightly roughened.	1874. Received, in Holland, interstitial iodine injections. Oct. 25, 1882. Lister technique. Excision. Rectangular U-shaped incision. Omo-hyoid, sterno-hyoid and sterno-thyroid muscles divided. "As soon as the tumor was extracted a multitude of forceps were applied to the arteries showing on all sides." Pedicle over trachea ligated en masse with catgut.	Recovery.	Quite bloody operation. Vessels clamped as encountered. No attempt to secure the thyroid arteries as preliminary step. The entire gland was probably excised.

TABLE I.—FRANCE.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
49	Boeckel, J. Thyroïdectomies. Fragments de chirurgie antiseptique, Paris, 1882, 468. Obs., p. 471. Thyroïdectomie partielle pour un goître du volume de deux poings. Lister. Guérison par première intention au bout de neuf jours.	F. 20 yrs.	Cystic colloidal goitre of right lobe. Circumference of neck 47 cm. Duration six years.	Suffocation for two months.	Sept. 16, 1880. Cyst punctured; extirpation of right lobe after ligature and division of the two thyroid arteries.	Recovery.	
50	*Idem.* Obs., p. 472.	F. 21 yrs.	"Cystic goitre, right side. Circumference of neck 40 cm., tumor is median." Duration six months.	.....	Date not given. Injections of iodine and evacuation of liquid. Aug. 26, 1880. Evacuation of cyst and extirpation of sac. Lister dressing.	Recovery.	
51	Beauregard, of Havre. Delens, Observation de thyroïdectomie. Bull. et mém. soc. chir., Paris, 1883, n. s., ix, 21.	M. 28 yrs.	"Three-lobed tumor about the size of an orange; central lobe the largest." Duration 14 years; rapid growth of late.	Suffocation; raucous voice, at times complete aphonia.	Sept. 5, 1882. After "isolation" of both lobes "the pedicle was so large and short that it prevented dissection and ligature of the thyroid arteries." Hence the tumor was transfixed by crossed steel rods and ligated under these by a rubber tube. Sept. 9. Severe hemorrhage; thereupon the rubber tube was replaced by a chain écraseur and the tumor removed.	Recovery.	"The tumor weighed 285 gm. The walls of the sac were thick, but pliable. The remains of the thyroid body were studded with numerous calcareous concretions." Authors, at this time, did not recognize adenomata as something to be distinguished from colloid goitre.
52	Pozzi, S., service of Professor Verneuil, Hôpital la Pitié, Paris. Goître plongeant parenchymateux et kystique. Extirpation après trachéotomie préliminaire. Forcipressure prolongée de l'artère thyroïdienne supérieure. Hémorrhagies secondaires. Mort. Gaz. méd. de Paris, 1883, s. 6, v, 510.	M. 17 yrs.	"Trilobed tumor occupying whole right side and center of neck, extending to left." Duration five years.	Modified voice; dyspnea; wheezing; suffocation attacks.	July 1 and 8, 1883. Tumor punctured by Verneuil. Aug. 1. Drainage tube "in the sac." (Verneuil.) Oct. 5, 1883. Operation by Pozzi. Chloroform. Tracheotomy to relieve asphyxia. Excision of both lobes. Operation difficult on account of the previous surgical treatment. Duration three hours. Evidently considerable hemorrhage. Two forceps on large vessel, accidentally wounded, were left in wound because ligation was found impossible.	† Died Oct. 8 about 10 a. m., 3 days post operation. Hemorrhage.	Oct. 7. Severe hemorrhage on removal of forceps was controlled by reapplication of several forceps. Oct. 8, 4 a. m. "Enormous loss of blood; hemorrhage controlled with difficulty, with about 10 forceps. Patient almost exsanguinated." Autopsy: The right superior thyroid artery found cut 7 mm. from its origin. "There was no clot in the artery. The right external carotid had apparently been caught in one of the last forceps."
53	Labbé, Léon. Kyste suppuré du corps thyroïde.—Accès de suffocation. Thyréoïdectomie. Guérison. Ann. d. maladies de l'oreille, du larynx et des organes connexes, Paris, 1883, ix, 146.	F. 28 yrs.	Firm, elastic, ovoid tumor, the size of a large egg, ending just above suprasternal hollow and lifting up the edge of the right sterno-mastoid. Duration nine months.	Dyspnea; dysphagia.	June 6, 1882. U-shaped incision, the branches measuring 7 cm. and 6 cm. across. The right incision followed the sternomastoid, and the left was a little beyond the midline. The tumor was isolated and enucleated. The cyst wall was ruptured, "nevertheless the extirpation of the sac could be entirely carried out." "The loss of blood was insignificant; there were few ligatures." Carbolic spray during whole operation. Lister dressing.	Recovery.	Post operation: "The wound preserved good aspect, with only a few drops of sero-purulent liquid from the drain."

TABLE II.—ITALY

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
1	Marzuttini, G. B. Gozzo enorme; infiammazione, suppurazione, cancrena. Settone. Ligatura della tiroidea superiore. Bull. delle sci. med., Bologna, 1846, s. 3, ix, 365. Originally published in Mem. delle med. contemporanea, xiv, 337.	F. Past middle age.	Enormous goitre "reaching to the hyoid bone, and laterally to the trapezius." The tumor covered the right breast and had an abscess at its extremity. Duration "since childhood."	Dyspnea; vertigo.	Oct. 6, 1844. Ligation of the superior thyroid artery. "Hemorrhage arising from certain arteries was soon controlled by ligature."	Recovery. Oct. 21, 1844. "Tumor" reduced one-half.	"The patient was seen not long before the publication of the paper, and she was in better health than before the ligation of the artery." Infection may, in part, have been responsible for the ultimate result. There was a large suppurating cavity within the tumor. For other low hanging goitres *vid.* Holmes (Great Britain, No. 23) and Perassi (Italy, No. 19).
2	Porta, Luigi, professore di clinica chirurgica in Pavia. Delle malattie e delle operazioni della ghiandola tiroidea, Milano, 1849, p. 135.	F. 26 yrs.	"Large hypertrophied tumor of the right lobe."	.....	April, 1835. Ligation of the right superior thyroid artery.	Recovery. Tumor not affected by the operation.	"The operation, ... in spite of some difficulty in discovering the artery hidden behind the summit of the swollen lobe, succeeded without accident per se."
3	*Idem.* P. 135.	M. 28 yrs.	"Large hypertrophied tumor of the right lobe."	.....	Nov. 30, 1846. Ligation of the right superior thyroid artery.	Recovery. Tumor not affected by the operation.	Patient died from erysipelas of the head three months after the healing of the wound. The lumen of the ligated artery was found to be normal below the ligature.
4	*Idem.* Obs. XI, p. 136.	M. 20 yrs.	Large goitre consisting of three lobes, the median as large as a turkey's egg, those on the sides each larger than a fist. Duration "from childhood."	Dyspnea.	May 9, 1848. Ligation of both superior thyroid arteries: the right, palpable, was tied in a "few minutes; the left, deep seated, in 15 minutes." Short vertical incisions.	Recovery. The tumor was diminished by one-third of original volume and remained so for four months when it "seemed disposed to grow again."	
5	*Idem.* P. 139.	M. 38 yrs.	"Very voluminous goitre."	Suffocation.	Dec., 1848. Venesection, without relief. Ligation of what was thought to be the enlarged inferior thyroid artery.	† Died on the day of operation.	"At autopsy it was noted with surprise that the ligature had been placed on the internal carotid artery." Cause of death not stated.
6	*Idem.* Obs. XII, p. 149.	M. 20 yrs.	"The tumor of the right thyroid lobe not larger than an orange." Duration "from childhood." "The left lobe appeared small and atrophied."	Altered voice; dysphagia; dyspnea; fatigue; cough; oppression in the chest.	Iodide pomade tried without effect. 1840. Tumor incised, "a coriaceous cyst as large as a turkey's egg was discovered, isolated and drawn out. Then were disinterred and extracted, two sarcomata of smaller size." Duration of operation one-quarter of an hour with loss of four or five ounces of blood and without the denudation of any adjacent organ except an anterior branch of the superior thyroid which was cut and twisted.	Recovery.	"After one month of suppuration the wound healed with total disappearance of the tumor and of the symptoms." Operator saw patient in 1848, eight years post operation. He was relieved of all symptoms and there remained no trace of the goitre.

TABLE II.—ITALY.—Continued

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
7	*Idem.* Obs. XIII, p. 150.	F. 25 yrs.	"Tumor, as large as a hen's egg, on the left side of the neck."	.....	Iodine tried without effect. Aug. 3, 1842. Ligation of the extremity of the trunk of the superior thyroid artery. Incision of tumor and excision of all the central "carne" in pieces.	Recovery.	Open wound. Phlegmon of neck and pulmonary disturbances. Venesection, purgatives, etc. All symptoms disappeared in two weeks. Wound healed in a month.
8	*Idem.* Obs. XIV, p. 151.	M. 9 yrs.	Tumor, the size of a hen's egg, "protruding at the summit of the right lobe of the thyroid gland beside the larynx."	.....	1843. The tumor, easily enucleated, was found to be a "sarcoma" the size of a "nut."	Recovery.	The "cortex" was divided to a depth of a millimeter. Thereupon the tumor was exposed.
9	*Idem.* Obs. XV, p. 152.	F. 16 yrs.	Goitre on the right side of the neck, size of a fist, "which pressed close to the lower jaw."	.....	Pomade of iodide and burnt sponge had been tried without effect. 1844. After torsion of an anterior branch of the superior thyroid artery, the tumor was split, exposing to view a circumscribed sarcoma the size of a hen's egg. This being enucleated, "the empty cortex collapsed." Loss of blood amounted to a few ounces.	Recovery.	Post-operation symptoms: Phlegmon of the neck; dysphagia and pain in the chest; headache; restlessness; fever. Treatment: "Six generous bleedings of the arm, 40 leeches at the temple, repeated purgatives, and most severe diet. After these measures the symptoms in the head, neck and chest disappeared and the wound, after copious suppuration, healed at the end of five weeks."
10	*Idem.* Obs. XVI, p. 153.	M. 24 yrs.	Tumor, the size of a lemon, in the left lobe.	Dyspnea; attacks of suffocation.	Iodine and burnt sponge had been tried without effect. 1845. Incision of tumor exposed a large coriaceous cyst which was excised except at the base, where the capsule was adherent to parts in the mediastinal region. Torsion was applied to a wounded artery.	Recovery.	"Inflammation in the wound was dissipated by two bleedings and 20 leeches. After copious suppuration the cavity was reduced to a fistula which closed in about two months."
11	*Idem.* Obs. XVII, p. 154.	M. 27 yrs.	Goitre, the size of a fist, in the right lobe, extending to the manubrium.	Mental anxiety; dyspnea; dry cough.	1846. "Extraction of two sarcomata the size of a "nut"; a cartilaginous cyst full of limpid serum was excised." Duration of operation "15 minutes without wounding vessels and without hemorrhage."	Recovery.	Post-operation symptoms: Fever, with swelling of the neck; difficulty in breathing; congestion of the head; somnolence. Treatment: "Five generous bleedings of the arm and in a week all the symptoms disappeared and the wound, after abundant suppuration, was reduced to a small fistula, which was still open when the patient left the hospital."

TABLE II.—ITALY.—Continued

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
12	Rizzoli, Prof. F., chir. primario nello Spedale Maggiore di Bologna. Gozzo sottosternale de tessuto erettile operato colla legatura del tumore. Collezione delle memorie chirurgiche ed ostetriche, Bologna, 1869, i, 112. Originally published by Rasi in Bull. delle scienze med. di Bologna, 1845, s. 3ª, vii, 237.	F. 27 yrs.	Rapidly growing, partly subclavicular, tumor. Diagnosed "Walther's aneurismatic goitre" because of "thrill and peculiar pulsation."	Attacks of suffocation; dyspnea; dysphagia.	1833. Ligation of the pedicle of the tumor. The ligature on subsequent occasions was drawn tighter.	Recovery.	"The tumor came away in the hands of the operator on the eighth day. A sudden spurt of blood was controlled by filling up the wound with lint and by light compression with the hand."
13	Porta, Luigi prof. di clinica chirurgica in Pavia. Della legatura delle arterie tiroidee per la cura del bronchocele. Annali universali di medicina, Milano, 1850, cxxxvi, 5.	F. 17 yrs.	Goitre on the left side of the neck the size of a mandarin. Duration from childhood.	Dyspnea; dysphagia.	July 28, 1850. Ligation of left inferior thyroid artery. Ligation of left superior thyroid artery. Duration of operation three-quarters of an hour.	Recovery. "Good health, no trace of the tumor."	First case of ligation of the inferior thyroid artery.
14	Bella, F. Storia di una cisti tiroidea felicemente guarita. Il morgagni, Napoli, 1876, xviii, 258.	F.	Cystic tumor of isthmus larger than a mandarin. Duration seven years.	.....	1875. Puncture of cyst. Iodine injections. Vertical incision about one month later. "The walls of the cyst were attached to the skin on each side by two sutures. Between the sutures the sac was incised. From the cyst came turbid liquid and granular matter." "Drainage tube for the first few days, and frequent injections of tincture of iodine and carbolic solution."	Recovery. "Some months after the discharge of patient there was no return of the tumor."	Post operation: "The cavity grew smaller day by day, and at the same time a small tumor appeared around the aperture. After two months there was only a fistulous opening terminating in the little tumor. Treatment with nitrate of silver soon closed this fistula."
15	Menzel, A., medico chirurgo primario, Ospitale Civico, Trieste. Struma cistica; estirpazione, guarigione. Resoconto sanitario dell'Ospitale Civico di Trieste per l'anno 1873, Trieste, 1876, ii, parte speciale, p. 93.	F. 18 yrs.	Cystic goitre, the size of a hen's egg. Duration two years.	.....	Aug. 11, 1873. Extirpation. Hemorrhage during operation was slight, but some hours post operation a more severe hemorrhage supervened, probably on account of the slipping of a ligature.	Recovery.	The patient was a cretin. Very brief account of case.

TABLE II.—ITALY.—Continued

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
16	Bottini, E., of Pavia. Estirpazione totale di gozzo parenchimatoso. Guarigione. Gior. della R. accad. di med. di Torino, 1878, s. 3, xxiii, 353. Obs. I, p. 365. (Read before the Accademia March 15, 1878.)	F. 28 yrs.	Parenchymatous goitre, the size of an infant's head, in the center of the neck. Duration from childhood.	Attacks of suffocation; voice low and thick; speech difficult; "respiration gasping with whistling."	Sept., 1868. Spedale Maggiore of Milan. Professor Albertini attempted extirpation, but had to desist on account of severe hemorrhage (according to the story of the patient). Severe suppuration lasted for months. His second attempt to operate was futile on account of hemorrhage. Jan. 22, 1877. Dr. Bottini. "The central part of the morbid mass was ligated and the mass removed." Duration of operation 30 minutes. Fifty-two ligatures were applied, without wounding a single vein or artery. Lister methods scrupulously adhered to.	Recovery.	"Twenty-five ligature threads, gathered together at the lower angle of the wound, came away little by little." Zambianchi, in 1873, refers to this case of Bottini's as the first total extirpation of goitre in Italian surgery. Perassi, at the meeting of the Accademia of April 5, 1878, refers to this communication of Bottini's, and gives a case of his own of removal of a very large "bronco-lipo-cele," which he accomplished in 1864. It does not seem quite clear that this was a total extirpation. First goitre case in which Listerism was employed in Italy. All vessels divided between two ligatures.
17	*Idem.* Obs. II, p. 371. Case given in greater detail in Gior. della R. accad. di med., Torino, 1878, s. 3, xxiv, 179. Altro caso di estirpazione completa di gozzo parenchimatoso. Guarigione.	M. 40 yrs.	Large parenchymatous goitre on the right side of the neck. Duration about two years.	.....	March 19, 1878. "Procedure the same as in the preceding case. Fifty-four ligatures were applied. While, on account of ligating the vessels before dividing, there was no spurt of arterial blood, there was enough blood lost to give the operator uneasiness at times.	Recovery.	Probably an excision of isthmus and right lobe.
18	*Idem.* Gior. della R. accad. di med., Torino, 1878, s. 3, xxiv, 170. Obs., p. 185. More fully described by Baiardi, Tansini and Brichetti. Gozzo cistico. Asportazione totale. Guarigione. L'osservatore gazz. delle cliniche di Torino, 1880, xvi, 131.	F. 18 yrs.	Cystic goitre, the size of a large mandarin, extending from one sternomastoid to the other, divided into two lobes, the right a little larger than the left. Duration four years.	Dyspnea.	1878. Total extirpation. "The operation was difficult, for in spite of proceeding with the greatest caution and always dividing the tissues between two ligatures, hemorrhage was severe." Forty-eight ligatures were applied.	Recovery.	Vertical incision. Tracheal "pedicle" of goitre surrounded by catgut ligature; ablation beyond ligature. This is probably the first total extirpation for Italy.
19	Perassi. Gozzo voluminoso esportato con successo mediante il taglio e la legatura. Gior. della R. accad. di med., Torino, 1878, s. 3, xxiii, 389. (Read at the meeting of April 5, 1878.)	M. 46 yrs.	An enormous goitre, "bronco-lipo-cele," which hung over the breast down to the abdomen. Duration 15 years.	.....	Aug. 18, 1864. Operation without anesthesia. The tumor was first punctured. The attempt to excise it had to be abandoned. Seven ligatures were passed through the pedicle; the tumor was then ablated.	Recovery.	The goitre in Marzuttini's case (No. 1) also hung down over the breast. In Timothy Holmes's case (Great Britain, No. 23) the cyst hung below the patient's waist.

TABLE II.—ITALY.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
20	Bottini, E. Tansini, Iginio, Estirpazione totale di gozzo retrosternale, eseguita con successo nella clinica operativa della R. universita di Pavia. Gazz. med. italiana, Lombardia, 1879, xxxix, 481.	M. 31 yrs.	Substernal goitre, the size of a small mandarin. Duration 22 years.	Dyspnea.	Nov. 10 (year?). Total enucleation of a tumor of the isthmus—partly substernal.	Recovery.	Bottini uses catgut for the peripheral ligatures; silk for the central. Strict antiseptic precautions.
21	Dionisio, F. Estirpazione di gozzo. Guarigione. L'osservatore. Gazz. delle cliniche, Torino, 1879, xv, 433.	F. 25 yrs.	Spherical tumor of isthmus, size of a fist. Duration about four years.	Dyspnea on exertion; suffocation from the slightest pressure on the tumor; dysphagia.	April 21, 1879. Tumor incised and emptied of its contents. Severe hemorrhage from the cavity was controlled by ligature of some small arteries and by compression sponges. The anterior portion of the sac was removed with scissors and the edges of the remaining portion were sutured to the margin of the skin-wound.	Recovery.	Operation similar to the eventration which Kocher performed upon intrathoracic goitres too large for delivery, but without justification in this case.
22	Berruti, L., Spedale Mauriziano di Torino. Grosso gozzo vascolare guarito colla legatura elastica. Gior. della R. accad. di med. di Torino, 1879, s. 3, xxvi, 140.	M. 49 yrs.	Large pendulous, cylindrical tumor of the neck, which covered part of the sternum. Duration 30 years. "After two years of growth a second tumor appeared on the first. The first tumor was hard, but the second was soft."	Hemorrhage from the tumor, necessitating surgical interference.	May 13, 1879. The pendulous tumor, skin included, was firmly ligated with an elastic cord. The skin was thrown into radiating folds by the ligature. May 18. The sloughing tumor was ablated 3 cm. from the ligature. Immediately a considerable hemorrhage occurred; a second encircling ligature was applied.	Recovery.	This performance resembles the proceeding of Matthias Mayor (1826).
23	Albertini, Professor, Ospitale Maggiore, Milan. Esportazione di gozzo. Gazz. degli ospitali, Milano, 1880, i, 476.	F. 57 yrs.	Large goitre. Duration eight years.	.....	Date not given. Extirpation. Twenty-two ligatures were applied. Very slight hemorrhage. Scrupulous antisepsis. Duration 32 minutes.	Recovery.	Very brief notes. Unable to state the nature of the operation.
24	Bottini, E. Baiardi, Tansini and Brichetti, Ipertrofia del lobo medio. Estirpazione. Guarigione. L'osservatore. Gazz. delle cliniche di Torino, 1880, xvi, 117.	F. 12 yrs.	Tumor, the size of a nut, immediately over the larynx. Duration one year.	.....	1877. Enucleation of tumor; ligation of pedicle.	Recovery.	
25	Bruno, L., and Novaro, in Turin. Canalis, Gozzo ipertrofico del lobo destro del corpo tiroide, con cisti a contenuto colloide. Estirpazione. Guarigione. *Ibid.*, p. 625.	M. 10 yrs.	Tumor, the size of a hen's egg, on the confines of right lobe and isthmus.	.....	Aug. 17, 1880. Exploratory puncture. Aug. 31, 1880. Enucleation; pedicle doubly ligated with catgut and the tumor ablated. Lister dressing.	Recovery.	Devecchi (*l. c.*) asserts that this operation was performed by Novaro, and that Bruno made only the exploratory puncture.

TABLE II.—ITALY.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
26	Ruggi, G., Ospedale Maggiore di Bologna. Folier, C. A., Gozzo follicolare con parziale degenerazione cistica curato coll' estirpazione della glandola tiroidea. Guarigione. Bull. delle scienze mediche, Bologna, 1880, s. 6, vi, 388.	F. 19 yrs.	"Tumor on the anterior and center of neck, the size of a fetus head at five months." Duration 13 years.	.....	June 29, 1880. Precise nature of operation not clear. Partial enucleation and trasfixion; ligation of pedicle over trachea in parts; ablation. Rupture of a cyst in course of the operation.	Recovery.	Vertical incision. Péan and Billroth forceps left hanging in wound for three or four days.
27	Medini, L. Storia di una voluminosa cisti multiloculare della tiroide guarita colla spaccatura. *Ibid.*, p. 263.	F. 67 yrs.	Tumor, the size of an adult's head, reaching from the lower jaw to the sternum and on the right and left to the anterior border of the trapezius. Duration about 41 years. Skin over tumor shiny, tense and livid.	Cyanosis; breathing stertorous; suffocation; alteration in the voice; cerebral symptoms.	The patient had been bled at the temple for cerebral symptoms with only temporary relief. 1880. Tumor incised, evacuation of about 900 gm. of colloid substance.	Recovery.	Explored with the finger, the tumor proved to be a cyst lined with calcareous plaques.
28	Bottini, E. Tansini, I. Sulla metodica estirpazione del gozzo. Gior. della R. accad. di medicina di Torino, 1880, s. 3, xxviii, 81. Obs. I, p. 84. Estirpazione di enorme gozzo parenchimatoso. Insuccesso.	M. 43 yrs.	Tumor in front and sides, size of the head of the patient. The surface of the tumor is nodular and overrun by large and numerous veins. Duration 24 years.	Dyspnea.	Feb. 14, 1880. Curved incision from the right mastoid process to the left sternomastoid. It was proposed to attack the tumor on the left. Although blunt dissection was used there was severe hemorrhage. Controlling the hemorrhage with difficulty, operator attempted to detach the tumor between double ligatures, but this did not succeed. Then the operator attacked it from above, proceeding now to the right and now to the left, and "thanks to about 200 ligatures," succeeded in removing the tumor.	† Died March 5, 1880, from sepsis.	Oblique collar incision. At autopsy two aberrant lobes were found behind the sternum and a lobe, probably aberrant, in the neck. These cases are often excessively vascular—some have been almost inoperable. I presume that this case was a very difficult one for the period, and that the operation was creditably performed by this masterful surgeon.
29	*Idem.* Obs. II, p. 88. Estirpazione completa di gozzo parenchimatoso retrosternale. Guarigione.	M. 19 yrs.	"Tumor in the lower part of the right carotid region, the size of a hen's egg." Duration one month.	.....	May 3, 1880. Enucleation.	Recovery.	The tumor contained a large cystic cavity filled with brownish blood. Microscopic examination showed fetal type of thyroid gland. This is the first mention that I have found of this type of tumor—Wölfler's classic monograph on tumors of the thyroid gland appeared the same year.
30	*Idem.* Obs. III, p. 90. Estirpazione completa di gozzo prevalentemente vascolare. Guarigione.	F. 60 yrs.	"In the lower two-thirds of the neck are two tumors, each the size of a mandarin, divided in the midline by a furrow." Duration a few months.	Dyspnea.	May 3, 1880. Local anesthesia. Enucleation of the tumors which were very vascular.	Recovery.	First mention of local anesthesia. Bottini used a blunt instrument in placing the ligatures—after the manner of v. Bruns and others of his day. He was evidently well supplied with artery clamps.

TABLE II.—ITALY.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
31	*Idem.* Sulla metodica estirpazione del gozzo. Gior. internazionale delle scienze mediche, Napoli, 1881, iii, 139. Obs., p. 143.	F. 70 yrs.	Trachea compressed by an enormous goitre.	.....	Date not given. Extirpation. The operation required 150 ligatures.	Recovery.	Bottini devotes only three lines to the report of this case, of which we find no mention elsewhere.
32	Colomiatti, Prof. V., Hospital of San Luigi, Turin. Devecchi, P., Contributions to the radical cure of goitre. The San Francisco Western Lancet, 1881, x, 241. Obs., p. 245.	M. 60 yrs.	Circumscribed tumor of the right lobe, extending back of the sternum. Duration from childhood.	Pain; dyspnea. Ulcer; erysipelas.	May, 1879. "Total extirpation" of the right lobe. Posterior suface of sternum denuded in course of operation.	† Died from pleuritis in a few days. Mediastinal infection.	Colomiatti was assisted by Devecchi, and on the death of the patient remarked to him that if he should meet with an identical case he would trephine the sternum and introduce a drainage tube for the free flow of the secretions.
33	Fiorani, G., chir.-prim. operatore all' Ospedale Maggiore di Lodi. L'esportazione del gozzo per mezzo del laccio elastico. Gazz. degli ospitali, Milano, 1881, ii, 241. Obs. I, p. 243. Gozzo di mediocre volume. Esportazione. Guarigione.	F. 19 yrs.	"Tumor, the size of an orange, situated to the right of the larynx." Duration nine years.	.....	May 16, 1880. Tumor partly enucleated and pedicle ligated. Antiseptic precautions were observed. Large vessels encountered were divided between two ligatures. Duration of operation "a few minutes."	Recovery.	May 21, 1880. "The greater part of the completely mortified tumor excised." May 31, 1880. "The ligature fell away and with it the pedicle."
34	*Idem.* Obs. II, p. 244. Gozzo molto voluminoso. Esportazione. Morte.	F. 25 yrs.	Tumor occupying the anterior part and both sides of the neck. Duration about two years.	Dyspnea. Goitre interferes with the movement of the neck.	Oct. 17, 1880. Tumor partly enucleated and pedicle ligated. "Antiseptic precautions scrupulously observed." Duration of operation 13 minutes.	† Died Nov. 7, 1880. "Typhoid fever." Death probably due to sepsis.	"The tumor was removed with scissors on the fourth day; erysipelas on the fifth day; the ligature came away on the 12th day. Aphonia was present after operation." Probably a left-sided lobectomy.
35	*Idem.* Obs. III, p. 247. Gozzo retrotracheale. Esportazione.	M. 13 yrs.	Hard goitre, the size of a large nut, firmly fixed to the right side of the trachea. Another tumor was palpated behind the trachea, a little to the left, the size of a large nut.	Labored breathing; feeling of suffocation at night.	Jan. 14, 1881. Tumor behind the trachea was partly enucleated and pedicle ligated.	Recovery.	"Three days after the operation the goitre was smaller. The ligature fell away on the 14th day."
36	Giommi, M. Estirpazione totale di gozzo follicolare-colloide, prima curato colle iniezioni parenchimatose di iodio. Raccoglitore medico, Forli, 1881, s. 4, xv, 13. Case, p. 14.	F. 40 yrs.	Very large globular goitre occupies the whole front of the neck and extends behind the manubrium. Duration many years.	The patient "has pellagra." Dizziness; noises in the ears; dyspnea.	May 22, 1879. No anesthetic. Longitudinal incision. Ligation of the short, thick pedicle. Hemorrhage from two openings in the hardened capsule of the goitre. Tightening the ligature did not control the hemorrhage. The margins of the openings were sutured and encompassed with a figure of eight ligature. The hemorrhage controlled, a metal thread was placed below the silk ligature, and the tightening begun. Bleeding occurred again, but a few twists of the vise controlled it.	Recovery.	May 23. Tumor ablated in front of the metal ligature which came away on the third day.

TABLE II.—ITALY.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
37	Novaro, G. F. Esportazione del lobo destro della tiroide; resezione della faringe; autoplastia delle faringe; morte per emorragia secondaria all'undicesimo giorno. Gior. della R. accad. di med. di Torino, 1881, s. 3, xxix, 34.	M.	Epithelioma of right thyroid lobe, secondary to cancer of larynx. Duration a few weeks.	.....	Jan. 10, 1881. Vertical incision. Removal of the tumor with the resection of the right wall of the pharynx. The opening in the pharynx was closed with a layer of skin. The ligature of the superior thyroid artery was displaced and violent hemorrhage occurred. Catgut ligatures were used.	† Died Jan. 25, 1881, suddenly from hemorrhage. Infection.	Aug. 19, 1880. Novaro extirpated the whole larynx for epithelioma. The enlargement of the right thyroid lobe was evidently a recurrence of the neoplasm.
38	Piccinelli, E. Contributo all'esportazione del gozzo coll'allacciatura elastica. Guglielmo da Saliceto. Gior. di med., farmacia e sci. affini, Piancenza, 1881-82, anno iii, 229.	F. About 19 yrs.	Spherical, midline goitre, the size of two mandarins, furrowed transversely by three lines and having the appearance of three lobes. Diagnosis: "Vascular and aneurysmatic bronchocele." Duration seven years.	For a year or more the voice has been harsh and hoarse. Attacks of dyspnea and dysphagia.	Jan. 26 (year?). In isolating the tumor embarrassing hemorrhage occurred. As the tumor had no real pedicle, a double elastic ligature was thrown around it to control the hemorrhage. Hemorrhage continued, and was controlled by "piazza hemostasis" and cotton and ice. About two hours post operation there was another hemorrhage. Lister precautions. Infection.	Recovery.	Patient became so exsanguinated in the course of the operation that an Esmarch bandage was applied above the pelvis.
39	Berruti, L., Ospedale Mauriziano, Turin. Tre casi di gozzo guariti colla esportazione. Gior. della R. accad. di med. di Torino, 1882, 3 s., xxx, 808. Obs. I, 808.	M. 11 yrs.	Rounded tumor on the right side, size of an orange. Duration about one year.	Severe dyspnea.	Puncture and iodine treatment without effect. April 16, 1882. Two cysts were removed on the right side. Finding the left lobe "hypertrophied" the whole gland was removed, according to the method of Billroth. The superior and inferior thyroid arteries were "previously ligated."	Recovery.	Longitudinal incision still employed. First instance in Italy of preliminary ligation of the thyroid arteries.
40	*Idem.* Obs. II, p. 809.	F. 42 yrs.	Colloid goitre, the size of a hen's egg, on the right side. Left lobe "especially hypertrophied." Duration from childhood.	Dyspnea; dysphagia.	Op. I.—June 5 (1882?). Removal of tumor on right side. Op. II.—June 22 (year?). "The entire thyroid gland was removed." This operation "was rather long and difficult."	Recovery.	The second operation was performed because no relief followed the first.
41	*Idem.* Obs., II, p. 811.	F. 18 yrs.	Large cystic tumor in an "hypertrophied" left lobe. Duration 18 months.	Dyspnea; dysphagia.	June 13, 1882. Left lobe of the thyroid gland entirely removed. "Each little vessel was ligated."	Recovery.	Presumably the "hypertrophy" of the left lobe which contained the cyst was due to presence of other adenomata.
42	Minich, Ospedale Civile di Venezia. Marta, G. B., Esportazione e guarigione di un gozzo mediante il laccio elastico. Gazz. med. ital., lombardia, Milano, 1882, xlii, 103.	F. 50 yrs.	Ovoid tumor at the level of the thyroid cartilage, on the right side of the neck, the size of a large orange. Near this is another small mobile tumor, the size of a pigeon's egg. Duration 34 years.	No symptoms.	Sept. 24, 1881. Enucleation of tumor. Elastic ligature applied to the base. Strict antiseptic precautions.	Recovery.	Sept. 27, 1881. With the scissors the gangrenous tumor was detached about one-half cm. from the ligature. Sept. 28. Patient is almost voiceless and unable to swallow. Oct. 19, 1881. The ligature fell away. Oct. 29. The difficulty in swallowing and loss of voice were of short duration.

TABLE II.—ITALY.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
43	Ruggi, G., Ospedale Maggiore di Bologna. Brugia, R. Due casi di gozzo follicolare curati con l'estirpazione della glandiola tiroidea. Guarigione. Raccoglitore medico, Forli, 1883, s. 4, xx, 373. Case I, p. 376.	M. 22 yrs.	Large tumor in front of the neck, divided in two by a longitudinal sulcus, the right side larger than the left. Duration 10 years.	Slight dysphagia; severe dyspnea; slight cyanosis; pupila are dilated and react very slowly.	Nov. 15, 1882. Excision of entire gland. Enucleation of a little nodule projecting from the right half of the gland which compressed the trachea. Fifty-four catgut ligatures were applied, the four thyroid arteries included. Rigorous antiseptic precautions were used. After the operation, as before, the pulse was 70.	Recovery.	Dec. 22, 1882. Pleurisy. Vertical incision supplemented by transverse ones; vessels ligated as encountered; isthmus ("pedicle") carefully dissected from trachea (for first time in Italy).
44	*Idem.* Case II, p. 387.	F. 12 yrs.	Hypertrophied thyroid, divided in two by a longitudinal sulcus, the right half flatter and extended, the left more prominent. Small hard, resistant nodules palpated between the right sterno-mastoid and the end of the right half of the tumor.	Severe dyspnea, accompanied by a sense of distress.	April 22 (year not given). Total excision of thyroid. The same method was followed as in the preceding case. Thirty-five catgut ligatures were applied. Antiseptic dressing.	Recovery.	Semilunar flap (for first time in Italy).
45	Bottini, E., University of Pavia. Zambianchi, F., Sulla metodica estirpazione del gozzo. Annali universali di med. e chir., Milano, 1883, cclxv, 350. Obs. I, p. 356.	M. 11 yrs.	"Parenchymatous goitre, the size of a small melon, in the middle of the neck, a little more developed toward the right." Duration about two years.	Dyspnea.	Dec. 6, 1881. Enucleation.	Recovery.	"The parenchymatous tumor was interspersed with small cysts."
46	*Idem.* Obs. II, p. 357.	F. 22 yrs.	"Parenchymatous goitre, the size of the head of an infant, occupying the front and sides of the neck. It is formed of three lobes, the left as large as the other two together." Duration 11 years.	Dyspnea; attacks of suffocation.	March 4, 1882. "Total extirpation." A severe hemorrhage occurred in isolating the tumor behind the insertion of the sternomastoid, which was controlled with difficulty.	Recovery.	Not clear that this was a total extirpation. Wound suppurated. "The tumor consisted of small cysts enclosed in colloid substance." "When 15 years old, patient was attended by Professor Porta at Pavia, who treated her with a seton."
47	*Idem.* Obs. III, p. 363.	F. 39 yrs.	Parenchymatous goitre, the size of the head of an infant, on the left side of the neck. Duration 19 years.	Dyspnea; voice weak; difficulty of speech.	April 25, 1882. This operation was just like the preceding one, the only difference being that some skin, which had been stretched over the tumor, was removed.	Recovery. Some disturbance of respiration on account of S-shaped deformity of the trachea.	"The tumor consisted of numerous cysts with colloid contents."
48	*Idem.* Obs. IV and V, pp. 365 and 366.	F. 17 yrs.	First admission: Jan. 21, 1882. Cystic adenoma, the size of a hen's egg, in the lower part of the right carotid region. Duration 10 years. Second admission: Jan. 24, 1883. Cystic adenoma, the size of a hen's egg, behind the left sternomastoid. Duration about two months.	Dyspnea. Dyspnea.	Four years previously the tumor had been punctured in the Pavia clinic. Op. I.—Jan. 31, 1882. "Operation was a little difficult on account of firm adhesions, but the tumor was isolated in a short time. Drainage; twisted sutures." Op. II.—Jan. 24, 1883. "Total extirpation."	Recovery. Discharged cured Feb. 26, 1882. Recovery. Post second operation, tetany.	The typical attacks of tetany, called convulsions, were first observed Feb. 6, 13 days after the second operation. The patient, greatly agitated, noisy and destructive, became unmanageable and was discharged Feb. 19. March 16, 1883, the patient returned to have a fistulous tract cured, but became so excited that she was again dismissed.

TABLE II.—ITALY.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
49	*Idem.* Obs. VI, p. 368.	M. 48 yrs.	"Cystic goitre with calcareus concretions on the right side of the neck, the size of a large melon." Duration 28 years.	Abscess, the result of treatment by leeches and poultices.	Dec. 14, 1882. Enucleation.	Recovery.	
50	*Idem.* Obs. VII, p. 370.	F. 21 yrs.	A tumor in the center of the neck, another to the left. To the right is a nodule the size of a mandarin with many nodules of varying sizes in groups. Diagnosis: "Goitre and sarcoma of left cervical glands." Duration of tumor in the center of neck, 10 years. Of the one to the left, 13 months.	Dyspnea; dysphagia; bass and raucous voice.	March 11, 1883. The two tumors and "the other glands" were removed. The wound was closed with two drainage tubes and twisted sutures.	† Died March 18, 1883. Pneumonia.	Autopsy: "The tumor was a sarcoma of the thyroid gland infiltrating all the cervical glands."
51	*Idem.* Obs. VIII, p. 374.	M. 16 yrs.	Cystic goitre, the size of an orange, in the lower part of the neck, a little to the left. Duration about five years.	Dyspnea; attacks of suffocation.	May 26, 1883. Enucleation. "Very little loss of blood." The tumor was found to extend below the clavicle. "The trachea did not assume its normal position, and the breathing was not improved."	† Died June, 5, 1883.	Autopsy: "A piece of the thyroid lobe was found reaching behind the trachea, compressing it laterally and pushing it to the right. This was undoubtedly the cause of the attacks of suffocation and of death."
52	*Idem.* Obs. IX, p. 376.	M. 63 yrs.	"Sarcoma of the thyroid filling completely the jugular fossa and reaching deeply behind the sternum. Duration about four months.	Voice bass and raucous; dyspnea; dysphagia; attacks of suffocation.	May 26, 1883. The operator did not succeed in freeing the tumor from the sides of the cartilage of the larynx or from the first rings of the trachea. Using the "Tauschbatterie" to control hemorrhage, the greater part of the tumor was cut out, and the remainder was scraped out with a Volkmann spoon.	Uneventful recovery.	Oblique longitudinal incision. Microscopic examination: "Sarcoma." "The wound healed by granulation." One would not have expected this.
53	*Idem.* Obs. X, p. 378.	F. 25 yrs.	Cystic tumor, as large as an orange, filling the jugular fossa and extending behind the sternum.	Low, raucous voice and difficulty in speaking; severe respiratory disturbance.	June 2, 1883. Slightly oblique incision from right to left. Not succeeding in isolating the tumor from above, the portion behind the sternum was lifted out, thus relieving the respiration. This portion was larger than appeared at examination, and its isolation was laborious on account of the firm adhesions and the large vessels encountered. Trachea small and flattened laterally.	Recovery.	Specimen: There were cysts, varying in size, in the tumor.

TABLE III.—GREAT BRITAIN AND IRELAND

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
1	Gooch, Benjamin. A brief account of broncho-celes. Med. and chir. observations, 1773, iii, 134.	F.	(?)	(?)	Ineffectual attempt at removal. Operation performed by another surgeon notwithstanding protest from Gooch.	† Died "in less than a week." Bleeding never controlled.	Operation discontinued on account of hemorrhage.
2	*Idem.*	F.	(?)	(?)	Nearly fatal hemorrhage. Gooch protested against the operation.	Recovery.	"The young lady's life was preserved only by having a succession of persons to keep constant pressure upon the bleeding vessels day and night for near a week, with their fingers upon proper compresses," *vid.* text.
3	Blizard, Sir Wm. Burns, Allan, Observations on the surgical anatomy of the head and neck, Edinburgh, 1811, p. 202. "From manuscript notes taken by Dr. Brown."	.....	.....	.....	Date not given. Ligation of "the arteries going to an enlarged thyroid gland." (Superior thyroid arteries.)	† Died of hospital gangrene.	Post operation: "In a week the tumor was reduced one-third in its size. The ligatures then sloughed off; repeated bleeding took place from the arteries, and by the extension of the hospital gangrene, the carotid itself was laid open."
4	Coats, Henry, R. C. S., surgeon of the Salisbury Infirmary. Cooper, Sir Astley, Case of bronchocele in which the superior thyroideal artery was successfully tied. Med. chir. trans., Lond., 1819, x, 312.	F. 17 yrs.	"The thyroid glands were large and pressed on the trachea."	Dyspnea; dysphagia.	Dec. 29 (1818?). Ligation of left superior thyroid artery.	Improved.	"Her breathing much improved and the size of the tumor reduced nearly half." "Discharged Feb. 14, quite well." Possibly infection of the wound contributed to the exceptional result.
5	Key, Guy's Hospital. Case of bronchocele. Lancet, Lond., 1824, ii, 358.	F. 28 yrs.	General enlargement of thyroid, particularly of right lobe. Duration two years.	Marked exophthalmus; nervousness; livid countenance; irritability; vertigo; headache; dysphagia.	June 11 (year not given). Ligation of right superior thyroid artery—undoubtedly only its median branch. Duration of operation one hour.	† Died two days post operation.	Unmistakably a case of Graves' disease. Graves' paper appeared in 1835. Operator greatly embarrassed by a superficial vein. First day post operation the patient was bled and cupped.
6	Earle, H., F. R. S., St. Bartholomew's Hospital. Case of bronchocele, in which the superior thyroid arteries were tied. Lond. Med. and Phys. Jour., 1826, lvi, 201.	F. 17 yrs.	Bronchocele of considerable magnitude, in front of neck. Duration four years.	Interrupted menstruation; dyspnea; dysphagia; headache. "State of health in every respect bad." Pulse 120. Greatly enlarged superior thyroid arteries.	Op. I.—Aug. 2, 1823. Ligation of right superior thyroid artery which was "as large as a carotid artery." Op. II.—Sept. 11, 1823. Ligation of left superior thyroid artery.	Recovery.	Tumor diminished in size. Dyspnea and dysphagia disappeared. Perhaps earliest case in which pulse rate is mentioned. Undoubtedly a case of hyperthyroidism. Perhaps the first operation for Graves' disease. Jan., 1824. "Health greatly restored." The infection which followed operation in these days was probably responsible for the good result of trivial operative measures.

TABLE III.—GREAT BRITAIN AND IRELAND.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
7	Green. Removal of the right lobe of of the thyroid gland. Lancet, Lond., 1829, ii, 351.	F. 24 yrs.	"Enlarged thyroid gland." No further details.	None mentioned.	May 22, ——. Operator believes that he removed the right lobe. "It was impossible to remove the whole of the gland on account of the large vessels in the neighborhood."	† Died about 15 days post operation, probably from infection.	Report of operation and of the case very meagre and indefinite; am ununable to state what part or what kind of gland was removed.
8	Liston, R., Edinburgh Royal Infirmary. Enlargement of the isthmus of the thyroid gland—removed. Lond. Med. Gaz., 1830, vi, 477.	M. 47 yrs.	Tumor of isthmus "larger than a goose's egg." Duration about three years.	Dyspnea; voice "considerably impaired."	Feb. 10, ——. Tumor "detached from its more loose connexions." The "remaining attachment" transfixed and ligated. Tumor left to slough away. "Surrounded the lower part of the tumor by two semicircular incisions."	Recovery.	Profuse bleeding—". . . . if the operation had been finished by means of the knife, the patient might have sunk before the hemorrhage could have been arrested, it being impossible to apply any great degree of pressure in that situation."—Liston.
9	Brodie, St. George's Hosptial. Ligature of the thyroid artery, for enlargement of the thyroid gland. Lancet, Lond., 1832, ii, 314 and 479.	M.	Tumor of right thyroid gland.	.....	June 21 (1832?). "Ligature of the right superior thyroid artery." Evidently its median branch.	Recovery.	No subsequent note.
10	Liston, Robert, North London Hospital. Wilson, W. J. E., Cases of removal of part of the thyroid gland. Brit. Annals of Med., Pharm., etc., Lond., 1837, i, 11.	F. 23 yrs.	Large goitre, greater on right side. Duration eight years.	Dyspnea.	Dec. 14, ——. Transfixion of tumor of right lobe and ligation. Removal by strangulation.	Recovery.	Probably cretinoid child.
11	Liston, Robert, F. R. S., University College Hospital. Bronchocele. Division of the sternomastoid muscle. Lancet, Lond., 1840, ii, 31.	M. 43 yrs.	Large bronchocele on left side of neck. Duration six years.	Dyspnea.	Jan. 28 (year not given). Sternomastoid muscle divided to relieve pressure.	Recovery. Dyspnea somewhat relieved.	No attempt made to remove the tumor. England's most dexterous operator evidently helpless when confronted with a goitre.
12	*Idem.* Bronchocele treated by ligature. Lancet, Lond., 1841, i, 691.	F. 13 yrs.	Bronchocele, size of small orange, on right side. "Always had slight swelling." Rapid increase in size in last two years.	Respiration impeded only "when child laughs."	Oct. 26, ——. Transfixion and ligation of pedicle.	Recovery.	Eighth day patient fainted from profuse secondary hemorrhage. Seventeenth day, hemorrhage.
13	*Idem.* Case I.—Encysted tumor on the thyroid body. Lectures on the operations of surgery, Phila., Liston & Mütter, 1846, 320.	..... 2½ yrs.	Encysted tumor, size of an apple, "upon the box of the larynx." Present from birth.	Caused no symptoms.	No date. Enucleation of "sac containing a thin pellucid fluid."	Recovery.	Relation to thyroid gland not determined.
14	*Idem.* Case II.—Cystic tumor on the thyroid body. Lectures on the operations of surgery, Phila., Liston & Mütter, 1846, 321.	M. 10 yrs.	Cystic tumor, size of small hen's egg, "front of throat." Existed since birth.	"Inconvenience."	Nov. 11, ——. Enucleation of cyst. Precise situation not stated. No vessels ligated.	Recovery.	Considered by Liston to be a tumor of the thyroid gland.

TABLE III.—GREAT BRITAIN AND IRELAND.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
15	Cusack, S. A., F. R. C. S., Steevens's Hospital. Case of dyspnea from bronchocele relieved by the division of the cervical fascia. Dublin Hosp. Gaz., 1857, iv, 276.	M. 17 yrs.	Bronchocele. Duration about four years.	On admission, March 12, 1857, laborious breathing. March 13, comatose; respiration 5; "pulse slow and feeble."	March 13, 1857. Laryngotomy and tracheal catheter.	Recovery.	Larynx and wound closed in seven days. ". . . . peas were placed in the external wound to keep up the discharge." Operator helpless.
16	Parsons, D. W., Dublin. Removal of an osseous tumor from the thyroid gland. Med. Times & Gaz., Lond., 1862, ii, 685.	F. 21 yrs.	Osseous tumor, size of bantam's egg, in right lobe. Duration about 10 years.	Dysphagia and aphonia.	Date not given. Enucleation.	Recovery.	Tumor, sawed in two, was found to be "composed of perfectly formed ossific matter."
17	Hamilton, E., F. R. C. S. I., Steevens's Hospital. Extirpation of the thyroid body. Dub. Quart. Jour. Med. Sci., 1865, xl, 315. Illustrations.	F. 16 yrs.	Large colloid goitre.	.....	June 10, ——. Both lobes were dislocated so as to protrude out of the wound. "Pedicle" tied by encircling ligature caused alarming asphyxia; therefore, transfixed and ligated.	Recovery.	Patient fainted from great loss of blood. The "pedicle" in this case was the part adherent to the trachea (the isthmus). Operator surprised to find that the goitre could be so easily dislocated.
18	King, K., Hull General Infirmary. Cases of bronchocele of the isthmus of the thyroid body; with remarks on the practicability of excision under certain circumstances. Case II. Brit. Med. Jour., Lond., 1865, ii, 5.	M. 21 yrs.	Bronchocele, size of a hen's egg, in front of trachea. Duration "long time."	Dyspnea.	Nov. 13, 1864. Incision, eventration and ligation of neck of sac. Tracheotomy two hours post operation, presumably necessitated by asphyxia due to the encircling ligature.	† Died two days post operation.	Autopsy: Both lobes studded with small tumors, evidently adenomata.
19	*Idem.* Case III, p. 6.	M. 21 yrs.	Bronchocele, size of a hen's egg, in front of trachea. Both lobes slightly enlarged. Duration three or four years.	Dysphagia; dyspnea.	May 9, 1865. Blunt enucleation of central tumor.	Recovery.	In course of operation, other tumors were observed on each side of the central one—operator "resisted temptation" to remove them.
20	Poland, Alfred. Tumor of the neck in connection with the thyroid gland; removal; structure thyroidal; recovery. Guy's Hosp. Reports, Lond., 1871, s. 3, xvi, 484. One woodcut showing a few follicles.	F. 40 yrs.	Tumor, "size of shaddock," front and right side of neck. Undoubtedly adenoma. Duration 26 years.	Dyspnea; dysphagia.	May, 1870. Enucleation. The tumor had only "an adhesive connection with the side of the thyroid gland." Operator realized that he had not removed the right lobe of the gland.	Recovery.	Carefully performed operation by an unusually competent surgeon.

TABLE III.—GREAT BRITAIN AND IRELAND.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
21	Durham, A. E., Guy's Hospital. Removal of cystic bronchocele. Lond. Med. Record, 1873, i, 209. Case first briefly reported in the Brit. Med. Jour., Lond., 1873, i, 286.	F. 36 yrs.	Cystic bronchocele of isthmus, size of large orange. Duration about five years.	Dyspnea; dysphagia.	Date not given. Enucleation.	Recovery.	The two lobes were seen and appeared to be normal. The tumor was, evidently, an adenoma with degenerated center.
22	*Idem.* Removal of bronchocele. Guy's Hosp. Gaz., 1873, ii, 38.	F. 47 yrs.	Bronchocele 19½ inches in circumference. Duration 20 years.	.....	Date not given. Either an excision of both lobes or enucleation of a large adenoma from each side. Description of operation not sufficiently definite.	Not stated.	Mr. Durham thought that thyrotomy would be an appropriate name for this operation. Torsion was applied to all the arteries; the veins were ligated with catgut.
23	Holmes, Timothy, surgeon to St. George's Hospital and professor of surgery and pathology, Royal College Surgeons. A case in which a large bronchocele was removed with fatal result. Amer. Jour. Med. Sci., Phila., 1873, n. s., lxv, 17. Illustration.	F. 65 yrs.	Enormous cyst of thyroid which hung below patient's waist. Weighed about seven pounds. Duration about 40 years.	So greatly reduced in strength that death seemed inevitable.	June 19, 1872. Skilfully and carefully performed extirpation. Vessels tied as encountered.	† Died 39 hours post operation. Hemorrhage and erysipelas.	*Vid.* abstract and illustration given in text. The innominate artery could be felt; the subclavian passed in front of the pedicle.
24	Jessops, Leeds General Infirmary. Cystic enlargement of thyroid body; extirpation; recovery. Lancet, Lond., 1873, ii, 841.	M. 7 yrs.	Cyst of right lobe and isthmus, size of small hen's egg. Duration about four years.	No symptoms.	Oct. 2, 1873. Extruded by pressure through incision of 2 inches. Pedicle at isthmus transfixed and ligated.	Recovery.	
25	Syme, James. Watson, P. H., Excision of the thyroid gland. Edinb. Med. Jour., 1874, xix, 252.	(?)	Cystic goitre.	.....	Cyst tapped and then opened, because "aneurismal signs" developed. Hemorrhage uncontrollable. The "patient died in our hands" writes Watson.	† Death from hemorrhage.	Note that in these recent days a great surgeon was powerless when confronted with blood vessels. Patrick Heron Watson assisted at the operation.
26	Spence, Prof. *Ibid.*	(?)	Tumor of isthmus of the thyroid gland.	.....	Extirpation of tumor of isthmus. "Great bleeding attending upon the division of the vascular connexion."	Recovery.	Watson assisted.
27	Watson, Patrick Heron, F. R. S., F. R. C. S. E., Edinburgh. Excision of the thyroid gland. Case I. Edinb. Med. Jour., 1874, xix, 252.	F.	"Central tumor, size of a China orange." Duration "many years."	.....	May, 1871. Excision of both lobes—the second lobe by his special method.	Recovery.	*Vid.* abstract and comments on Watson's method in text. Profuse hemorrhage on freeing the first lobe.
28	*Idem.* Case II, p. 253.	F.	Multilocular cystic goitre, size of two fists.	Anemia; slight degree of exophthalmus. Pulse not mentioned.	May, 1871. Excision of both lobes by Watson's method.	Recovery.	The goitre was probably made up of adenomata with cystic degeneration. In course of operation the long silk ligature, which included the vessels of the left superior pole, slipped. The gush of blood was controlled by pressure of sponge, no attempt being made to catch the vessels.

TABLE III.—GREAT BRITAIN AND IRELAND.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
29	*Idem.* Case III, p. 254.	F.	Multiple cystic goitre.	Anemia; exophthalmus. No mention of other symptoms of hyperthyroidism.	Autumn 1871. Excision of both lobes by Watson's method.	Recovery. "The anemia and exophthalmia which were present on admission, markedly diminished after the operation."	Catgut ligatures used and cut short. Presumably an adenomatous goitre, inasmuch as patient had exophthalmus.
30	*Idem.* Case IV, p. 254.	F.	Multiple cystic goitre.	.....	1872. Excision of both lobes—Watson's method.	Recovery.	
31	*Idem.* Case V, p. 254.	F.	Multiple cystic goitre, size of large fist; it "had grown steadily for 23 years."	Anemia; exophthalmus. The goitre pulsated.	March 1, 1872. Excision of both lobes.	Recovery. No note as to effect of operation upon the exophthalmus.	"A pulsating swelling" with bruit developed in the situation of the right superior pole six weeks or more after operation. "It then presented all the characters of an aneurysm with a venous communication." In about three weeks it disappeared.
32	*Idem.* Excision of the thyroid gland. Brit. Med. Jour., Lond., 1875, ii, 386. Case VI, p. 387.	(?)	.....	.....	Watson's method.	Recovery.	
33	*Idem.* Case VII, p. 387.	(?)	.....	.....	Watson's method.	Recovery.	
34	*Idem.* Case VIII, p. 387.	(?)	Large tumor adherent to the trachea.	.....	Watson's method.	† Died a few hours after operation.	Profuse hemorrhage. Death caused by aspiration of blood into wounded trachea.
35	Dowson, C. H. Hypertrophy of thyroid gland, and successful removal of right lobe. Trans. Bristol Med.-Chir. Soc., 1874-78, i, 71.	F. 13 yrs.	"Enlarged thyroid gland," right lobe larger than left.	"On July 28, 1874, she appeared premoribund, with stridulous breathing and livid countenance."	July 28, 1874. Excision right lobe. Superior and inferior thyroid vessels ligated as adhesions, but not recognized.	Recovery and relief.	The nature of the goitre is not stated Creditable operation.
36	Holthouse, Westminster Hospital. Gibb, Sir G. Duncan, Division of the isthmus to relieve dyspnea in certain cases of bronchocele. Lancet, Lond., 1875, i, 120. Case I, p. 121.	F. 29 yrs.	Enlargement of thyroid gland, right lobe the larger. Isthmus decidedly enlarged. Duration two years.	Facial turgescence; dyspnea; discomfort and tension about neck; nausea and vomiting for about 10 days.	July 11, 1874. Excision of isthmus.	Recovery and relief.	Sir Duncan writes, "I believe that this is the first occasion in which the isthmus has been either wholly removed or divided, at my suggestion." He would prefer, as a rule, to have "a good large portion of the isthmus" removed.

TABLE III.—GREAT BRITAIN AND IRELAND.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
37	*Idem.* Case II, p. 121.	F. 17 yrs.	Tumor "of the entire front of the neck." Duration since birth.	Dyspnea; dysphagia; laryngeal cough; facial turgescence.	Dec. 15 (1874?). Aneurism-needle armed with double thread passed under the isthmus. The ligatures were tied at two points with the idea that sloughing would take place between them.	Recovery.	
38	Ticehurst, H. R. Tumor of the thyroid gland. Brit. Med. Jour., Lond., 1875, i, 59.	....	Pendulous tumor, size of "small melon."	.....	Nov. 4, 1874. Blunt dissection. Encapsulated growth removed by galvano-cautery.	Recovery.	Meagre description.
39	Spence, Professor, Royal Infirmary, Edinburgh. From notes of Mr. T. F. Chavasse. Excision of a large bronchocele. Lancet, London, 1877, ii, 843.	F. 13 yrs.	Large bronchocele involving the entire gland. Right side of neck larger than left. Duration three years.	Dyspnea; "thrill over præcordia; first cardiac sound at apex somewhat thumping; second sound accentuated. No exophthalmus."	Sept. 28, 1877. Total excision after method of Patrick Watson, except that the isthmus was divided and each lobe removed separately.	† Died within 24 hours; possibly of hyperthyroidism.	Clever operation. Trachea flattened from side to side. Sterno-hyoid, omo-hyoid and thyro-hyoid muscles divided. "Considering the vascularity of the organ, comparatively little hemorrhage occurred." First instance in Great Britain of division of isthmus and removal separately of each lobe.
40	McLeod, Surgeon-Major K. Successful removal of bronchocele. Indian Med. Gaz., Calcutta, 1880, xv, 250.	M. 29 yrs.	Goitre, "size of child's head, more prominent on the right than on the left side." Duration eight years.	Respiration and deglutition not impeded.	July 22, 1880. Excision of entire gland, according to the method of Watson, the author states. Antiseptic precautions.	Recovery.	From the author's description of the operation one would conclude that the method employed was not precisely Watson's. Professor McConnel, who examined the specimen, compared its size to a man's fist.
41	Purcell, F. A. Cancer Hospital, Brompton. Removal of the right lobe of the thyroid. Lancet, Lond., 1880, ii, 339.	F. 23 yrs.	Tumor, size of duck's egg, right side of neck, extending from about third ring of trachea to upper border of thyroid cartilage, overlapped by edge of sterno-mastoid muscle. Thickening of isthmus. Duration three years.	.....	July 20, ——. Blunt dissection and excision, right lobe and isthmus. Antiseptic precautions, including carbolic spray.	Recovery.	The tumor was probably an adenoma and presumably enucleable.
42	Rose, W. Tumor of thyroid; removal. Brit. Med. Jour., Lond., 1881, i, 232.	F. 27 yrs.	Bronchocele, size of a turkey's egg, right lobe. Duration eight years.	Dyspnea; suffocation; pain.	Dec. 16, 1880. Blunt and bloodless enucleation and ligation of pedicle with "loop of carbolized catgut."	Recovery.	"The tumor was found to be composed of hypertrophied gland tissue." It was, presumably, an adenoma.
43	Whitehead, W., F. R. C. S., F. R. S., Edin., Manchester Royal Infirmary. Excision of the thyroid gland. Brit. Med. Jour., Lond., 1881, ii, 779.	F. 51 yrs.	Pendulous goitre extending from thyroid cartilage to sternum. Both lobes enlarged. Duration 30 years.	Dyspnea; suffocation; hoarseness.	May 21, ——. Excision of entire thyroid gland by Watson's method. Antisepsis.	Recovery.	June 29, ——. "The voice has been daily improving, and in every other respect the patient had regained perfect health."

TABLE III.—GREAT BRITAIN AND IRELAND.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
44	Pitts, B., Resident Surgeon, St. Thomas's Hospital. Case of bronchocele in which the thyroid was removed during an attack of dyspnea. Case I. Tr. Path. Soc., Lond., 1882, xxxiii, 364.	M. 15 yrs.	"Bronchocele." Duration eight years.	Dyspnea.	Oct. 26 (1881?). Preliminary venesection from jugular vein; only 1½ ounces dark blood flowed. Tracheotomy. Gland was removed "without the loss of any material additional blood."	† Died the day after operation.	Meagre report.
45	*Idem.* Case II, p. 365.	F. 33 yrs.	Large bronchocele mainly on left side. Duration "ever since she could remember."	Great dyspnea; stridulous breathing; voice hoarse; left vocal cord paralyzed.	Dates not given. Op. I.—Gland incised. Op. II.—Gland incised. Op. III.—Tracheotomy.	† Died about six weeks after first operation.	Operations undertaken in attacks of extreme dyspnea.
46	Barker, A. E. Excision of small goitre: recovery. Brit. Med. Jour., Lond., 1883, i, 1066.	F. 21 yrs.	Tumor of right lobe, 3 inches in transverse diameter, 2 inches in vertical. Evidently an adenoma. Duration seven years.	Dyspnea, paroxysmal at times; anemia and "vascular excitement."	Aug. 24, 1881. Excision of right lobe. Vessels tied as encountered.	Recovery.	Prior to operation had been treated with leeches, injection of iodine, seton, electricity.
47	May, Bennett, Queen's Hospital, Birmingham. Case of excision of large bronchocele, with preliminary tracheotomy. Brit. Med. Jour., Lond., 1883, i, 1227.	F. 42 yrs.	Large tumor "covering the trachea from the hyoid bone down to the sternum." Duration 20 years.	Dyspnea; cough; voice faint and husky; slight exophthalmus.	(1881?). Preliminary tracheotomy. Excision.	† Died four days post operation.	Treated with injections and with hydrofluoric acid, iodine, ergotin, etc., by mouth. Tapped and only blood obtained. Death "apparently from suppurative bronchitis." Operator states that it was "probably an adenoid tumor undergoing sarcomatous change."
48	Stoker, W. T., F. R. C. S., professor anatomy, Royal College Surgeons, Ireland. On removal of the thyroid gland. Tr. Acad. Med., Ireland, Dublin, 1883, i, 231, 295.	M. 17 yrs.	"Enormous goitre involving the entire gland." "Hanging down as low as the abdomen." Duration since birth.	"Cretinish"; constant cough; laryngeal irritation; stridulous breathing; "impending death."	March 10, 1882. Op. I.—Excision of right lobe and isthmus. Two and one-half hours. March 8, 1883. Op. II.—Excision of left lobe. Two hours. Antiseptic precautions.	† Died fifth day after second operation, sepsis and pulmonary thrombosis.	Difficult operations, cautiously and admirably performed. Autopsy: Thrombosis of pulmonary artery and of internal jugular, innominate and superior cava veins, due undoubtedly to the infection of the wound which had filled with blood.
49	Jones, Sydney, St. Thomas's Hospital. Enlargement of the thyroid gland in a male, producing pressure on the trachea and serious attacks of dyspnea; removal of isthmus; atrophy of lateral lobes; cure. Lancet, Lond., 1883, ii, 900.	M. 18 yrs.	"Greatly enlarged thyroid gland." Duration seven or eight years.	Dyspnea.	March 17, 1883. Excision of isthmus between silk ligatures, which were left hanging out of wound "for drainage." Drainage tube.	Recovery. Complete relief.	The trachea was found at operation to be flattened from side to side. May 4, 1883. "The thyroid cannot be felt."

TABLE IV.—UNITED STATES AND CANADA

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
1	Harris, Charles, New York, 1807. Gross, S. D., Diseases of the thyroid gland. System of Surgery, Phila., 1882, 6th Ed., il, 354.	F.	Goitre extending from chin to sternum and from ear to ear. Duration 22 years.	.....	1807. Freed with knife and fingers up to tracheal attachment; base tied off with stout ligature.	Recovery.	Only two small arteries tied.
2	Mott, Valentine, professor of surgery, N. Y. *Ibid.*	.....	.....	.....	Removed goitre weighing three pounds.	† Died.	
3	Jameson, H. G., Baltimore, Md. Case of bronchocele relieved by taking up one of the superior thyroid arteries. American Medical Recorder, Phila., 1822, v, 116.	F.	General enlargement of thyroid gland. More or less circumscribed tumor of left lobe. Duration about 20 years.	Dysphagia; difficulty of speech; strong pulsation of left carotid and superior thyroid arteries.	May 10, 1821. "Superior thyroid artery" ligated with "animal ligature."	Recovery.	Mistaken for aneurism of carotid by many physicians.
4	Smith, N. R., professor of surgery, University of Maryland, Balto., Md. Extirpation of the thyroid gland. North American Archives M. & S. Sci., Balto., 1835, ii, 309.	F. 40 yrs.	Large, somewhat pendulous, tumor of right lobe. Duration presumably 20 years.	Ulceration of skin over lower part of tumor.	Date not given. Probably an enucleation of large adenoma of right lobe.	† Death on the 13th day post operation. Sepsis.	Case fully described in text. Operation skillfully performed. Superior thyroid artery wounded and secured early in operation.
5	Hoyt, O. Tumor of the thyroid gland successfully extirpated. Boston Med. & Surg. Jour., 1847, xxxv, 297.	F. 30 yrs.	Large tumor of left lobe. Duration five years.	Dysphagia; dyspnea.	Aug. 13, 1835. Extirpation of tumor, probably an adenoma. Dissection from below upwards along inner border.	Recovery.	Inferior thyroid artery closed by torsion; furious bleeding from accidentally divided superior thyroid artery controlled by actual cautery applied blindly in pocket. Patient was bled 18 ounces on day following operation.
6	Otis, G. A., Richmond, Va. A report of a case in which an enlargement of the isthmus of the thyroid body was successfully extirpated. Virginia Med. & Surg. Jour., Richmond, 1854, ii, 115.	F. 26 yrs.	Tumor of isthmus, size of hen's egg. Thick fibrous capsule, very vascular interior. Duration 12 years.	Dysphagia; dyspnea.	Sept. 7, 1853. Removed by strangulation; transfixion with two needles armed with double ligatures of silk, the eight ends of which were tied each to the ones adjacent.	Recovery.	"The internal portion of the tumor closely resembled the parenchyma of the placenta, a similitude I borrow from Sacchi, who has noticed this species of goitre." It was "a spongy tissue composed almost exclusively of a congeries of enlarged vessels."
7	Toland, H. H., San Francisco, Cal. Enlargement of the isthmus and right lobe of the thyroid gland with bony deposit; operation; cure. Pacific Med. & Surg. Jour., San Francisco, 1858, i, 53.	M. 26 yrs.	Enlargement of isthmus and right lobe. "Irregular and large portions of bone rested on the trachea." Duration nine years.	Vertigo; dyspnea; aphonia.	Dec. 1, 1857. Short incision into tumor and eventration. Profuse hemorrhage controlled by ligating wall of sac under transfixing tenaculum.	Recovery.	On eventration "blood gushed from the wound in fearful quantity."

TABLE IV.—UNITED STATES AND CANADA.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
8	Cooper, E. S., professor of anatomy and surgery, University of the Pacific, San Francisco. Operation for the removal of bronchocele. Death of the patient. Cinn. Lancet & Observer, 1860, iii, 15.	F. 24 yrs.	Circumscribed bronchocele, left side, extending from clavicle to chin. Duration four years.	Tumor apparently so vascular that consultants diagnosed aneurism.	No date. Futile attempts to use écraseur. Excision after preliminary ligation of the carotid.	† Died five hours post operation. Hemorrhage.	Inferior thyroid and four other arteries tied in course of operation. Abstract in text.
9	*Idem.* Cutting away of bronchocele without hemorrhage, with a case. Remarks. Med. & Surg. Reporter, Phila., 1862, viii, 38.	F. 27 yrs.	Bronchocele of isthmus, size of hen's egg. Duration 10 months.	"Mental anxiety."	March 27, 1861. Transfixed above and below, tied, and excised above ligatures.	Recovery.	States, in general way, that he has previously transfixed thyroid tumors so as to include the thyroid arteries and then transfixed the gland in many places and ligated.
10	Voss. Successful removal of thyroid gland. Amer. Med. Times, N. Y., 1862, iv, 10.	F. 54 yrs.	Tumor, size of fist, chiefly in left lobe and slightly substernal. Duration 42 years.	Dysphagia; dyspnea; deflected trachea.	Date not given. Removed by écraseur.	Recovery.	Profuse venous bleeding, unmanageable until écraseur was applied.
11	Smith, T. S., Lexington, Mo. Operation for the removal of a single goitrous tumor of the neck. Amer. Med. Times, N. Y., 1863, vii, 168.	Negro. M. 34 yrs.	Cystic tumor, left side.	.....	July 1, 1863. Ligation of artery supposed to be inferior thyroid; operation abandoned for fear of fatal hemorrhage.	.....	Another large vessel, size of goose quill, arising from subclavian, "dipped into the tumor on the under side, passed through it, and again showed itself running along the superior border of tumor . . . . then dipped into it again." Smith believed this to be the transversalis colli. *Vid.* text for Valentine Mott's observations.
12	Cheever, D. W., surgeon, Boston City Hospital, Boston, Mass. Bronchocele originating in America; operation; recovery. Boston Med. & Surg. Jour., 1866, lxxiii, 332.	F. 24 yrs.	"Solid" tumor, a little to the right and just below the larynx. Size 1½ inches by 2 inches.	.....	July 19, 1865. Excision of entire gland. "No very great hemorrhage." The left lobe at operation was found to be much larger than the right.	Recovery.	Only one of the two cases was operated upon. "The ready removal of it without profuse hemorrhage would seem to indicate early surgical interference with these growths." The descriptions of the growth before and at operation conflict. Am in doubt as to the nature of the enlargement.
13	Greene, W. W., Portland, Me. Successful removal of a large bronchocele. Med. Record, N. Y., 1866-67, i, 441.	F. 45 yrs.	Bronchocele weighing 1 pound 9 ounces. Duration 26 years.	Dysphagia; dyspnea; headache; giddiness.	Aug., 1866? Operation badly described; apparently a one-sided lobectomy.	Recovery.	"Fearful hemorrhage" from veins on exposing the tumor. Pedicle "containing three large arteries," which were his "guides for dividing pedicle into three parts with the fingers."

TABLE IV.—UNITED STATES AND CANADA.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
14	Marshall, E. L., Keithsburg, Ill. Extirpation of the entire thyroid gland. Recovery. Chicago Med. Jour., 1867, xxiv, 97.	M. 40 yrs.	Tumor weighing 1 pound 11 ounces. Duration many years.	Dyspnea; attacks of suffocation; headache; despondency.	Jan. 18, 1852. Excision of entire gland. Anesthesia declined by patient. Careful ligation of the four thyroid arteries as preliminary to excision.	Recovery.	Operation admirably performed. Marshall reports a lobectomy by Geo. McClellan, Sr., of Philadelphia. (Date not given.)
15	Warren, J. Mason, Boston, Mass. Large encysted thyroid tumor of the neck. Incision. Recovery. Surgical observations with cases and operations, Boston, 1867, 506.	F. 56 yrs.	Large cystic tumor occupying whole front of neck, from chin to sternum. Duration 54 years.	"Fullness in head."	Op. I.—June 20, 1860. Cyst incised and tent introduced. Op. II.—June 30, 1860. "Sac freely incised and covered with large poultice."	Recovery.	
16	*Idem.* Thyroid tumor. Twice removed. *Ibid.*, p. 507.	F. 35 yrs.	Cyst of right lobe. Subsequent cyst in same situation, size of an apple. Duration about seven years.	First tumor painful. Second tumor caused dyspnea.	Op. I.—Nov., 1851. Extirpation of cyst. Op. II.—May, 1858. Incision of sac and ligation of mouth of sac.	Recovery.	Cyst probably only partially removed at first operation. Repeated hemorrhages for five days after second operation. Sac obliterated by suppuration.
17	Blackman, G. C., professor of surgery, Medical College, Ohio. Pendulous pedunculated bronchocele successfully removed. Amer. Jour. Med. Sci., Phila., 1870, n. s., lix, 93.	F. 36 yrs.	Oblong tumor of isthmus 3½ inches long, circumference 4 inches, "looking much like a banana." Duration 15 years.	Tumor had caused no symptoms. Operation to relieve "unsightly deformity."	Feb., 1869. Extirpation. Blunt dissection; tumor wrenched from its connections.	Recovery.	Tumor being completely isolated was "suddenly wrenched from its connections," thereupon appalling hemorrhage from superior and inferior thyroid arteries. Bleeding controlled by sponges retained by transfixing needle and twisted suture.
18	Greene, W. W., Portland, Me. Three cases of bronchocele successfully removed. Amer. Jour. Med. Sci., Phila., 1871, n. s., lxi, 80. Case II, p. 81.	F. 40 yrs.	Tumor, size of small orange, in right lobe.	Dysphagia.	Oct. 25, 1869. Enucleation.	"Recovery."	Simple operation except for "adhesions to esophagus."
19	*Idem.* Case III, p. 82.	F. 35 yrs.	Tumor "involving both lobes, being of immense size."	Headache; vertigo; dysphagia; dyspnea; aphonia; thrill; bruit. "Pulsated everywhere." Diagnosed aneurism by "a prominent surgeon."	Jan. 20, 1870. Probably a double lobectomy. Vertical transfixion along midline and ligation of "pedicle" on both sides. "Most fearful hemorrhage."	.....	Before operation "considered the chances 100 to 1 that she would die on the table. . . . ." *Vid.* text for author's description.

TABLE IV.—UNITED STATES AND CANADA.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
20	Maury, F. F., Philadelphia Hosp. Extirpation of the thyroid gland for cystic enlargement. Case I. Photographic Review of Med. & Surg., Phila., 1871-72, ii, 17.	F. 23 yrs.	Very large cystic goitre, probably of isthmus and right lobe. Duration 14 years.	Dysphagia; pain; slight dyspnea.	April, 1871. Excision carefully performed after ligation of four thyroid arteries.	Recovery.	Operations well performed in bloodless manner.
21	*Idem.* Case II, p. 17.	Sex and age not given.	"Another very large growth" similar to that in case given above.	.....	1871. Precise date not given. Similar operation as in case given above.	† Died three weeks post operation. Pneumonia.	The operation was practically bloodless. The patient recovered normally and at the time of death the wound was almost healed.
22	Hodder, E. M., F. R. C. S., Eng., professor obstetrics, Trinity Hospital, Toronto, Canada. Fibro-cystic disease of the right half of the thyroid gland and its removal. Canada Lancet, Toronto, 1873, v, 159.	F. 18 yrs.	Tumor, size of pullet's egg, at right side of the larynx. (Fibro-cystic.) Duration 2½ years.	Dysphagia; "voice seriously affected."	Op. I.—April 10, 1872. Unnamed surgeon removed "upper portion only of the tumor." Op. II.—Oct. 31, 1872. By Hodder. Enucleation-excision of right lobe, which was hypertrophied and contained an adenoma.	Recovery.	Voice somewhat restored. Dysphagia disappeared. Superior and inferior thyroid arteriea were the only ones which required ligation.
23	Fenwick, G. E., Professor of clinical surgery, McGill University, Montreal, Canada. A case of fibro-cystic bronchocele. Removal of the right half of the thyroid body. Canada Med. & Surg. Jour., Montreal, 1873, i, 208. Case, p. 211.	F. 21 yrs.	Fibro-cystic tumor. "Huge central mass and two lateral" portions. Duration 18 years.	Dyspnea.	About June 8, 1872. Excision of both lobes. Ligation of superior and inferior thyroid arteries "which appeared small." Tumor twice tapped previously.	Recovery.	Presumably an excision of both lobes. The tumor consisted of three distinct lobes. A ligature was applied to the pedicle over trachea. Creditable operation.
24	Milligan and Tupper, Wabasha, Minn. Removal of right lobe of the thyroid gland, for cystic degeneration. Med. & Surg. Reporter, Phila., 1875, xxxii, 361.	F. 40 yrs.	Large cystic tumor, right lobe. Duration a number of years.	Anxiety; nervousness; slight dyspnea; slight dysphagia.	No date. Enucleation and removal by écraseur, right lobe.	Recovery.	Relatively trivial operation.
25	Nelson, W., Physician accoucheur to the Female Home, etc., Montreal. Fibro-cystic bronchocele. Operation and recovery. Canada Med. Record, Montreal, 1875-76, iv, 79.	F. 32 yrs.	"Fibro-cystic bronchocele, size of small teacup," in left lobe. Duration 16 years.	Difficulty in breathing at times.	Oct. 24, 1874. Probably an enucleation of an adenoma.	Recovery.	Left superior thyroid artery ligated in course of operation.

TABLE IV.—UNITED STATES AND CANADA.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
26	Hamilton, Frank H., New York. Division of isthmus of the thyroid gland to relieve dyspnea in bronchocele. Med. Record, N. Y., 1876, xi, 4.	M. 50 yrs.	Large bronchocele which encircled the trachea.	Dyspnea so excessive as to necessitate support of tumor by an attendant for three days prior to the operation.	Jan. 8, 1849. Division of isthmus and removal, perhaps, of part of goitre without relief of dyspnea. Hence tracheotomy.	† Died three days and four hours post operation.	Cause of death not stated.
27	Gay, G. W., Massachusetts General Hospital, Boston, Mass. Goitre. Bost. Med. & Surg. Jour., 1876, xciv, 727.	F. 20 yrs.	Solid tumor 6 inches x 8 inches. Duration two years.	Slight tracheal obstruction.	March 25, 1876. Enucleation of tumor—probably adenoma. Pedicle in midline transfixed and tied.	Recovery.	Simple operation. Carbolic acid dressing. First case in America in which mention is made of an antiseptic. Year of Lister's visit to America.
28	Homans, J., Carney Hospital, Boston, Mass. Cystic adenoma of the thyroid; excision; cure. Bost. Med. & Surg. Jour., 1876, xciv, 44.	F. 32 yrs.	Cystic adenomata of isthmus of left lobe. Duration eight years.	Dyspnea.	Op. I.—Nov. 21, 1875. Excision-enucleation of tumor over trachea. Cretaceous contents. Op. II.—Dec. 15, 1875. Excision-enucleation of tumor of left lobe.	Recovery.	After first operation: Left vocal cord immovable. Operation carefully performed by blunt dissection and in fairly bloodless manner.
29	Willoughby, W. A., Colborne, Ontario. Sinclair, J. A., Removal of right thyroid gland. Canada Lancet, Toronto, 1876-77, ix, 73.	M. 19 yrs.	Right thyroid gland enlarged. (Somewhat larger than human heart.) Duration four years.	Pressure on larynx. "Death from dyspnea was likely soon to result."	Date not given. "Removal of the right thyroid gland." Probably an enucleation of an adenoma.	Recovery.	
30	Miner, J. F., Sisters of Charity Hospital, Buffalo, N. Y. Feasibility of extirpating the thyroid gland in some cases of disease, with report of a case. Buffalo Med. & Surg. Jour., 1876-77, xvi, 323.	M. 15 yrs.	Cystic tumors of right gland. Duration eight years.	Dyspnea.	Enucleation. No large vessels encountered.	Recovery.	Profuse bleeding from small vessels at base of tumor seared by actual cautery.
31	*Idem.* Wall, C. A., Removal of the thyroid gland. Buffalo Med. & Surg. Jour., 1877-78, xvii, 207.	M. 42 yrs.	Large calcified and cystic adenoma of isthmus. Duration 23 years.	Slight suffocation at night.	Oct. 25, ——. Enucleation. The inferior thyroid arteries were ligated and divided.	Recovery.	Extirpation of tumor composed of cysts and calcified masses, measured 9 inches in circumference, 3¾ inches in breadth, 4 inches in length, 2½ inches in thickness. The ligatures of silk were left long.
32	Fuller, Wm. Successful removal of right lobe of thyroid gland by the knife. Detroit Lancet, 1878, i, 883.	F. 40 yrs.	Tumor, size of an orange, right lobe.	Neuralgia in back of neck, shoulder and head; tingling sensation in the arms and hand.	April, 1878. Excision-enucleation of right lobe—partly substernal. Superior thyroid artery accidentally torn and secured with difficulty.	Recovery.	"The wound was closed when suppuration was fully established, and the ligatures came away slowly during three or four weeks." Pedicle ligated with waxed cobbler's thread.

TABLE IV.—UNITED STATES AND CANADA.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
33	McLean, R. A., lecturer on anatomy University of California. Two successful cases of extirpation of the thyroid gland for fibro-cystic tumors. Case I. Western Lancet, San Francisco, 1878-79, vii, 263.	F. 56 yrs.	Large "fibro-cystic tumor." Duration about 15 years.	Pain; suffocation; dysphagia.	Op. I.—Sept., 1877. Free incision into the sac; drainage until healed from bottom. Op. II.—Oct. 15, 1877. Excision of left lobe and isthmus; possibly of right lobe also.	Recovery.	A portion of the anterior wall of the pharynx and the greater cornua of the hyoid bone were cut away in course of the operation. "Branches of the inferior and superior thyroid arteries were cut and tied, but the hemorrhage was insignificant."
34	McLean, R. A., San Francisco Female Hospital. *Ibid.* Case II, p. 265.	F. 30 yrs.	Large fibro-cystic tumor. Duration 14 years.	Pain.	Jan. 16, 1878. "Enucleation of tumor. A few vessels were cut and ligated."	Recovery.	
35	Maclean, Donald, professor of surgery, University of Michigan. Cystic goitre, complicated by epilepsy. Excision of the cyst. Recovery with complete and permanent cure of the epilepsy. Physician & Surgeon, Mich., 1879, i, 9.	M. 29 yrs.	Cystic goitre, size of an orange.	Sleeplessness; epilepsy.	Cyst tapped twice. March 18, 1876. Enucleation of cyst. Profuse hemorrhage controlled by transfixion ligatures.	Recovery.	The epilepsy followed an injury of the head. Three years post operation: No return of epilepsy.
36	Devecchi, P. Contributions to the study of the radical cure of goitre. San Francisco Western Lancet, 1881, x, 241.	M. 24 yrs.	Large cystic goitre of right lobe and isthmus. Duration eight years.	Dyspnea.	June 16, 1881. Enucleation of cyst.	Recovery.	No large blood vessels were encountered. Operation carefully performed.
37	McGraw, T. A. Operation of the thyroid gland. Detroit Clinic, 1882, i, 1.	.....	.....	.....	.....	.....	Unable to obtain the original communication.
38	Wyeth, J. A., surgeon to Mt. Sinai Hospital, New York. Some cases of goitre recently treated by excision. Med. Record, N. Y., 1882, xxi, 94.	F. 22 yrs.	Tumor of left lobe and isthmus.	.....	July, 1881. Cystic portion of tumor aspirated and injected with tincture of iodine, by Dr. Gerster. Sept. 7, 1881. Excision-enucleation. Superior and inferior thyroid arteries ligated, and finally the pedicle *en masse*.	Recovery.	Cure with aphonia, which is believed to have disappeared. The tumor was probably an adenoma with cystic center, and enucleable.
39	Byrd, W. A., St. Mary's Hospital, Quincy, Ill. Connell, G. W., Extirpation of thyroid gland by enucleation. Med. & Surg. Reporter, Phila., 1882, xlvi, 111.	F. 3 yrs.	Tumor weighing 8 ounces. Duration one year.	Dyspnea.	Dec. 6, 1881. Enucleation.	Recovery.	

TABLE IV.—UNITED STATES AND CANADA.—CONTINUED

No.	Operator and Publication	Sex and Age	Location and Duration	Symptoms	Operation	Result	Remarks
40	Cheever, D. W., surgeon Boston City Hospital, Boston, Mass. Excision of the goitre. Case I. Med. & Surg. Reports, City Hosp., Boston, 1882, 3 s., p. 130.	F. 36 yrs.	Solid tumor, size of small orange, in front and to right of trachea. Duration four years.	"Great pain."	Date not given. Extirpation by blunt dissection. Pedicle transfixed, ligated; tumor was cut away and the base burned with the galvano-cautery.	Recovery.	Dr. Cheever's operative work may be regarded as typical of the best methods in America of the period. He enucleated small tumors of the thyroid, but considered removal of a large double bronchocele as "out of the question," although in 1865 he apparently removed the entire gland. *Vid.* case No. 12.
41	*Idem.* Case II, p. 131.	F. 23 yrs.	Solid tumor, size of lemon, to right of midline, and small one, correspondingly situated, on left side. Duration two years.	.....	Dec. 14, ——. Extirpation by blunt dissection. Transfixion ligatures of pedicle, tumor cut away, and base burned with the galvano-cautery.	Recovery.	Wound dressed with carbolized oil and syringed daily.
42	*Idem.* Case III, p. 133.	"Young girl."	Small circumscribed tumor of "one lobe."	.....	Date not given. The tumor "was removed without hemorrhage." No particulars.	Recovery.	Described in only three lines.
43	*Idem.* Case IV, p. 133.	"Young lady."	Bronchocele. Small circumscribed tumor.	.....	Date not given. Tumor "removed without trouble."	Recovery.	A four-line description.
44	McIntyre, J. H. Reported by Watkins, W. W., St. Louis, Mo. A partial extirpation of a remarkably large bronchocele. St. Louis Med. & Surg. Jour., 1883, xlv, 409.	M. 29 yrs.	General enlargement of thyroid gland. Duration nearly eight years.	"Impeded cerebral circulation"; eyes somewhat prominent; mental anxiety.	May 10, 1883. Left lobe removed by "the tear-process or enucleation." Left superior thyroid artery torn through near its origin. Operator unable to determine whether inferior thyroid artery had been divided or not.	Recovery.	Probably a mild case of Graves' disease. Three months post operation: The remaining portion of the gland (the pyramid and right lobe) had decreased one-third and the cerebral symptoms had nearly disappeared. Crude operation.
45	Wyeth, J. A., surgeon to Mt. Sinai Hospital, New York. Goitre. Excision. Cure. Med. Record, New York, 1883, xxiv, 566.	F. 16 yrs.	Circumscribed tumor of right thyroid lobe. Duration four years.	.....	Oct. 10, 1883. Excision-enucleation. Superior and inferior thyroid arteries ligated, and finally the pedicle en masse.	Recovery.	The remains of the right lobe probably removed, as well as the tumor.

TABLE V.—GERMANY, AUSTRIA AND SWITZERLAND

Author and Publication	Number of Cases
Hildanus, Fabric. (1596)	1
Hildanus, Fabric., ii, 399; Hildanus, F., Opera, p. 216, Obs. xxxv; Langenbeck, Chirurgie, Bd. v, 306. (Ref., Günther.)	
Vogel, A. F.	1
Observationes quaedam chirurgicae defendit, Kiliae, 1771. (Ref., Günther.)	
Freitag, J. H. (about 1694)	1
Epistola de glandulae thyroideae, partim osseae, partim meliceridis fromam referentis Extirpatione, Lipsiae, 1778; Weiz, Neue Auszüge aus Dissert. f. Wundärzte, Bd. iv, 66; Langenbeck, Chir., Bd. v, 304. (Ref., Günther.)	
Eichenberg	1
Epheremid. med. physic. germ. acad. Natur. curios. Dec. ii. Ann. v, 453; Langenbeck, Chirurgie, Bd. v, 304. Anm. (Ref., Günther.)	
Kergel, Saxony (about 1800)	1
Bernstein, J. G., Praktisches Handbuch f. Wundärzte, Leipzig, 1800, N. Aufl., Th. iii, 604.	
v. Walther, Ph.	1
Neue Heilart des Kropfes durch die Unterbindung der oberen Schilddrüsenschlagadern, u. s. w., Sulzbach, 1817. (Ref., Chelius, M. J.)	
v. Klein, Stuttgart	3
Jour. d. Chir. u. Augen-Heilk., Berlin, 1820, i, 106.	
Zang	1
Höring, Rust's Magazin f. d. gesammte Heilk., Berlin, 1820, vii, 314.	
Hedenus, J. A. W., Dresden (about 1800)	6
Jour. d. Chir. u. Augen-Heilk., Berlin, 1821, ii, 237.	
v. Walther, Ph.	1
Jour. d. Chir. u. Augen-Heilk., Berlin, 1821, ii, 584.	
Fritze, Cl.	1
Hedenus, A. G., Tractatus de glandula thyreoidea, Lipsiae, 1822, 256, footnote 612.	
Gräfe, Berlin (1820)	3
Hedenus, A. G., Tractatus de glandula thyreoidea, Lipsiae, 1822, 255, 276, 292.	
Ohle, Dresden	1
Hedenus, A. G., Tractatus de glandula thyreoidea, Lipsiae, 1822, 291.	

Author and Publication	Number of Cases
Weiss, Dresden	1
Hedenus, A. G., Tractatus de glandula thyreoidea, Lipsiae, 1822, 291.	
Wedemeyer	1
Neue Bibliothek f. d. Chir. u. Ophthalmologie (Langenbeck), Göttingen, 1822, iii, 185.	
Schmidt, H., Paderborn	1
Zartmann, De strumae extirpatione, Dissert., Bonn., 1829, 26. (Ref., Günther.)	
v. Walther, Ph.	2
Zartmann, De strumae extirpatione, Dissert., Bonn., 1829, 22 and 26 (Ref., Günther.)	
Mandt, Greifswald (about 1832)	1
Rust's Magazin f. d. gesammte Heilk., Berlin, 1832, xxxvii, 387.	
Langenbeck, Göttingen	1
Langenbeck's Chirurgie, 1834, v, 303.	
Madelung, Gotha (1844-46)	1
Schmidt's Jahrb., Leipzig, 1847, lvi, 279.	
Dieffenbach, J. F., Leipzig	1
Dieffenbach, Die Operative Chirurgie, Leipzig, 1848, ii, 331.	
Pirogoff, N.	1
Rapport médical d'un voyage en Caucase, St. Pétersbourgh, 1849; Schmidt's Jahrb., 1850, lxvii, 116. (Ref., Günther.)	
Schuh, Wien	3
Wien. med. Wochenschr., 1859, ix, 641 and 657.	
Klein, A.	1
Dissert., Tübingen, 1860, 30.	
Schuh, Wien	1
Wien. med. Wochenschr., 1860, x, 145.	
Meeh, Brackenheim	4
Med. Corresp.-Bl. d. württemb. ärztl. Vereins, Stuttgart, 1861, xxxi, 227.	
Name of operator not given	2
Deutsche Clin., 1861, 167. (Ref., Günther.)	
Middeldorpf, P., Breslau	1
Lebert, Krankheiten der Schilddrüse, Breslau, 1862, 220.	
Franke, Leipzig (about 1834)	1
Günther, G. B., Lehre v. d. blutigen Operationen am menschlichen Körper, Leipzig u. Heidelb., 1864, 369.	
Bovet, A.	1
Gaz. des. hôp., Paris, 1865, xxxviii, 105.	

Author and Publication	Number of Cases
Sick, P., Stuttgart	1
Med. Corresp.-Bl. d. württemb. ärztl. Vereins, Stuttgart, 1867, xxxvii, 199.	
Gärtner, Stuttgart	1
Med. Corresp.-Bl. d. württemb. ärztl. Vereins, Stuttgart, 1867, xxxvii, 303.	
Hofmockl,	2
Wien. med. Presse, 1869, x, 39, 64, 90.	
Emmert, Bern	3
Brière, V., Inaug. Dissert., Lausanne, 1871, 40, 41, 42.	
Hopmann, Köln	1
Deutsche Zeitschr. f. Chir., Leipzig, 1873, ii, 185.	
Lücke, A., Bern (1865-72)	10
Deutsche Zeitschr. f. Chir., Leipzig, 1873, ii, 337.	
v. Chelius, F., Dresden	5
Jahresb. d. Gesellschaft f. Natur- und Heilk., Dresden, 1874, 13.	
Kappeler, O., Münsterlingen	28
Chir. Beobachtungen aus dem Thurgauischen Kantonsspital Münsterlingen, 1865-70, Frauenfeld, 1874, 99 (five cases). Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 314 (1868-1882, 28 cases).	
Gärtner, Stuttgart	3
Med. Corresp.-Bl. d. württemb. ärztl. Vereins, Stuttgart, 1876, xlvi, 233.	
Küster, E., Berlin (1875)	1
Bruberger, Deutsche Mil. ärztl. Zeitschr., Berlin, 1876, v, 453.	
v. Bruns, V., Tübingen (1851-70)	28
Süskind, Inaug.-Abhandl., Tübingen, 1877.	
Rose, E. (1878)	5
Arch. f. klin. Chir., Berlin, 1878, xxii, 1.	
Billroth, Th. (1860-81)	84
Wölfler, A., Wien. med. Wochenschr., 1882, xxxii, 5.	
Martin	1
Rev. méd. de la Suisse romande, Genève, 1882, ii, 590.	
v. Riedel	1
Wien. med. Wochenschr., 1882, xxxii, 1109.	
Kocher, Th., Bern (1872-83)	102
Arch. f. klin. Chir., Berlin, 1883, xxix, 300.	
v. Bruns, V. and P., Tübingen (1877-81)	14
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 317.	
Kuhn, St. Gallen (1878-80)	8
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 318.	

Author and Publication	Number of Cases
Czerny, Heidelberg (1872-81)	11
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 319.	
Maas, Freiburg i. B. (1878-81)	10
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 320.	
Kottmann, A., Solothurn (1879-81)	9
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 321.	
Bircher, Aarau	5
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 328.	
Kaufmann, Zürich (1880-81)	3
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 329.	
Niehans, P., Bern (1880-81)	3
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 329.	
Baumgärtner, Baden-Baden	2
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 329.	
Borel, F., Neuchâtel (1877-82)	15
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 330.	
Haffter, Frauenfeld (1881-82)	4
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 333.	
Courvoisier, Riehen (1881)	2
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 334.	
Berney, A., Rolle (1855)	1
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 335.	
Emmert	2
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 255.	
Krebs	3
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 255.	
Gussenbauer	11
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 255.	
Albert	9
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 255.	
Boéchat	1
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 255.	
Schläpfer (1881)	1
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 255.	
v. Muralt, W., Zürich	108
Kocher, Th., Arch. f. klin. Chir., Berlin, 1883, xxix, 255, footnote.	
Julliard, G.	31
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Total	575

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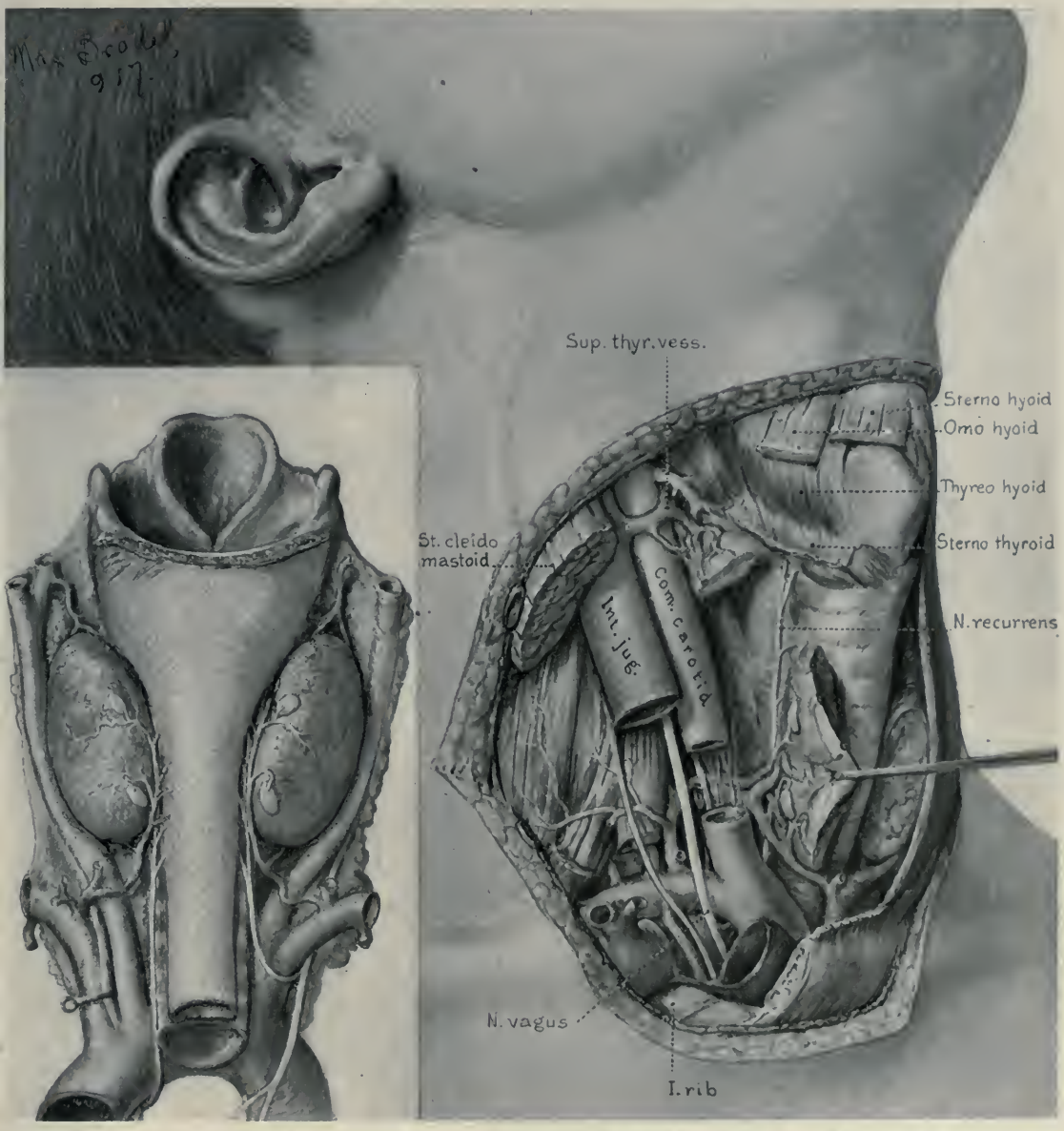
370. *Idem:* Ueber die Entwickelung u. den Bau d. Kropfes. Arch. f. klin. Chir., Berlin, 1883, xxix, 1.
371. Wyeth, J. A.: Some cases of goitre recently treated by excision. Medical Record, N. Y., 1882, xxi, 94.
372. *Idem:* Goitre—excision—cure. Medical Record, N. Y., 1883, xxiv, 566.
373. Zambianchi, F.: Sulla metodica estirpazione del gozzo. Ann. univ. di med. e chir., Milano, 1883, cclxv, 350. (Reports Bottini's cases, Obs. i to x, 356 to 378).
374. Zang: Höring, Rust's Magazin f. d. gesammte Heilkunde, Berlin, 1820, vii, 314.
375. Zartmann: De strumae extirpatione, Dissert., Bonn, 1829. (Unable to verify.)



Dissection of the operative field. The right lobe of the thyroid gland has been removed in the typical manner, a slice having been left posteriorly in order to preserve the integrity of the parathyroid bodies and the recurrent laryngeal nerve. This slice is drawn toward the midline with a hook. The insert, slightly elaborated by Mr. Broedel, was drawn for the author by Mr. H. M. Evans in 1907 from one of many dissections made by the latter for his study of the arterial supply of the parathyroid glands.

FIG. 1.—The little knots of silk mark the midline and guide the operator in closing the wound.

FIG. 2.—The skin and platysma muscle have been divided.

THE OPERATION FOR EXOPHTHALMIC OR HYPERPLASTIC GOITRE.

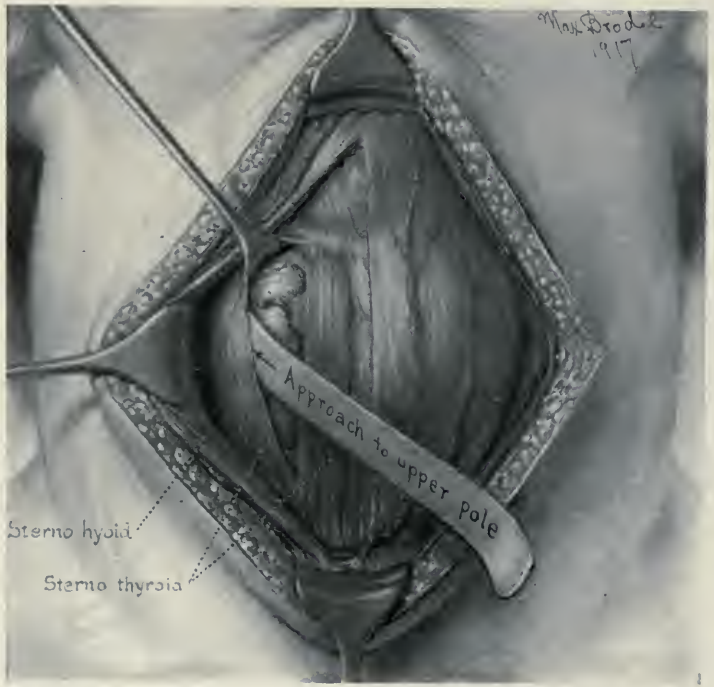


FIG. 1.—The spatula introduced between the gland and the sterno-thyroid muscle is contributed by the artist in order to carry the lettering.

FIG. 2.—At this stage of the operation the muscles are drawn away from the lobe by one broad, deep concave retractor instead of by the two small ones which in this and the preceding drawing serve to define clearly the two retracted muscles. The superior pole is caught between two finely pointed clamps.

THE OPERATION FOR EXOPHTHALMIC OR HYPERPLASTIC GOITRE.

FIG. 1.—The tip of the superior pole has been divided between the clamps.

FIG. 2.—The lobe is rolled inwards and the blood vessels have been clamped at a safe distance from the recurrent nerve and the parathyroid glands. Clamps are employed in greater number than is indicated in the drawing.

THE OPERATION FOR EXOPHTHALMIC OR HYPERPLASTIC GOITRE.

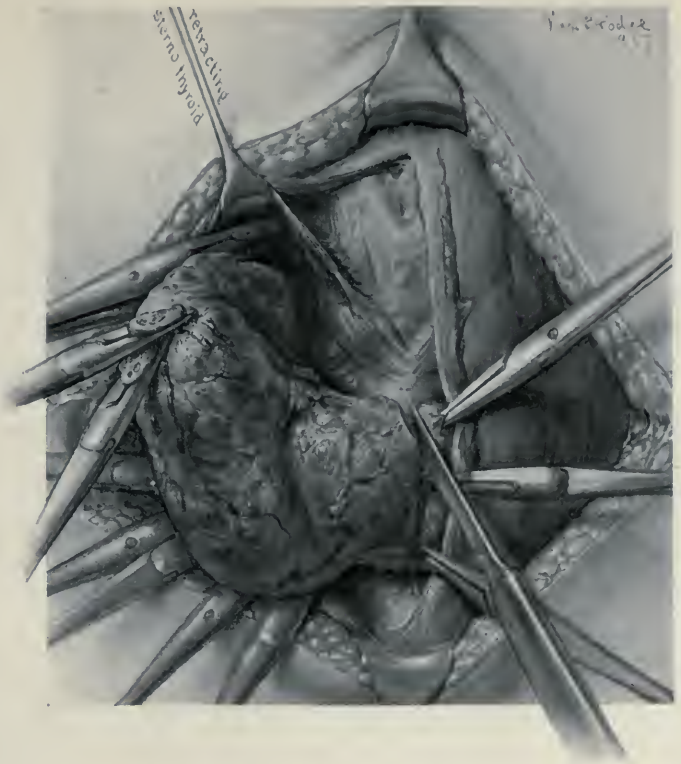


FIG. 1.—The act of dividing the isthmus. Usually, before division, the isthmus is freed from the trachea by a slender blunt dissector and ligated on the hitherto undisturbed side.

FIG. 2.—The isthmus has been divided, and the lobe, rolled outwards, is being sliced through just distal to the girdle of clamps shown in Plate XVII, Fig. 2.

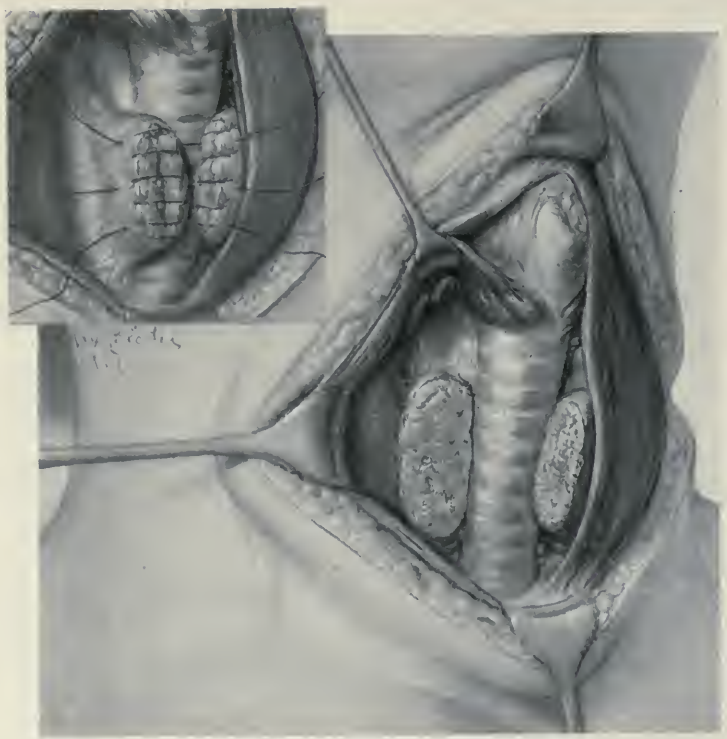


FIG. 1.—Occasionally, but rarely, the stump of the excised lobe rides forward as shown in the insert; and in a few such instances I have sutured it to the stump of the isthmus. The stitches over this stump are usually of the mattress type; in any event they become buried on tying.

FIG. 2.—The wound is closed without drainage. For the sake of clearness the artist has depicted a coarser silk than we use for these sutures.

THE OPERATION FOR EXOPHTHALMIC OR HYPERPLASTIC GOITRE.

FIG. 1.—The suture of the platysma muscle. Note the short straight needle which is much used in our clinic.

FIG. 2.—Shows the central stitch in line with the landmarks above and below.

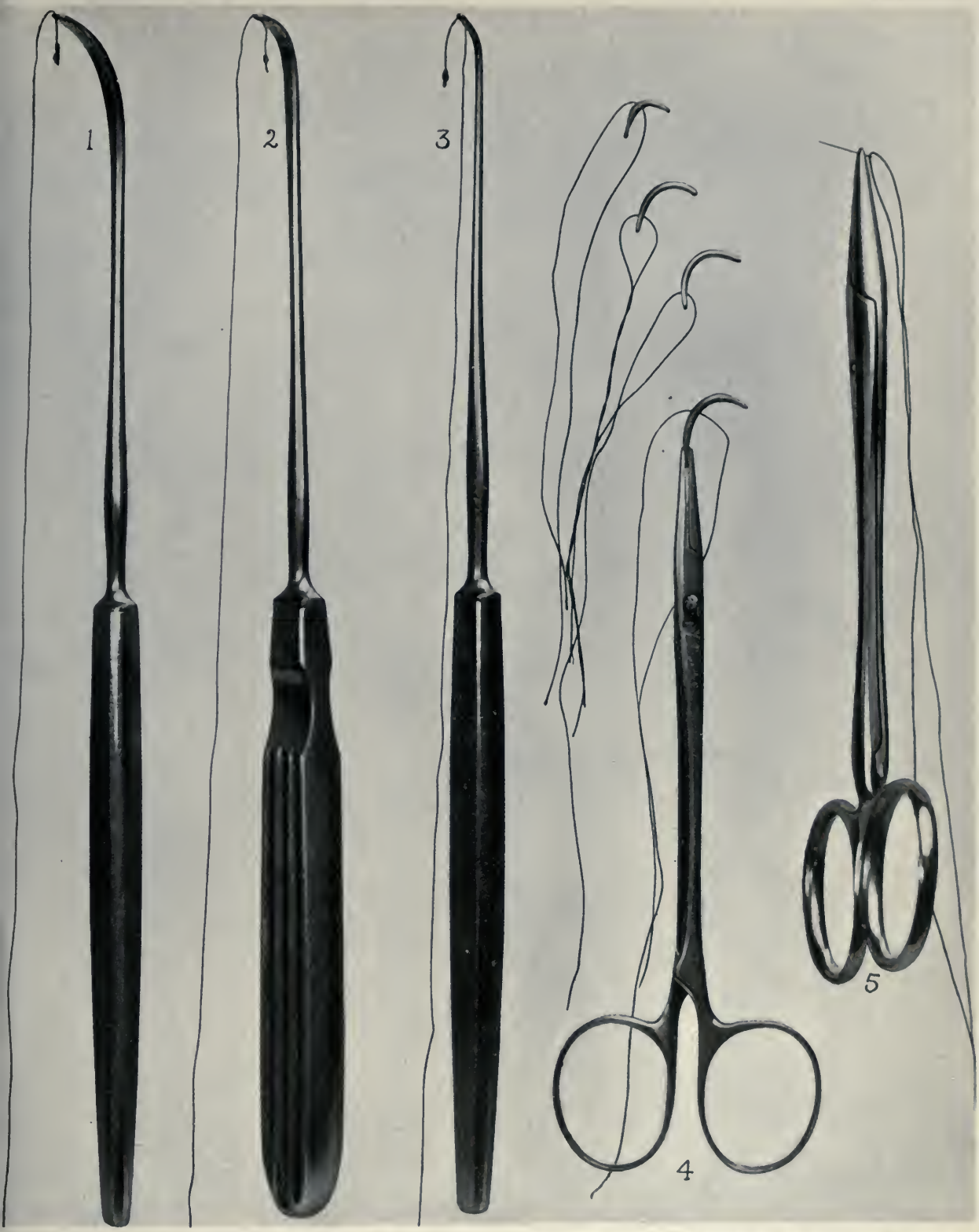
THE OPERATION FOR EXOPHTHALMIC OR HYPERPLASTIC GOITRE.

FIG. 1.

FIG. 2.

FIGS. 1 AND 2.—One of the methods which we employ in enucleating an adenoma. The lower clamp is applied as close as possible to the tumor which partly extrudes itself on removal of this clamp after the incision (Fig. 2) is made between the clamps into or through the superior pole.

ENUCLEATION OF AN ADENOMA.



FIGS. 1 AND 2.—Curved, fine-edged dissectors armed with a thread in the manner described in the text. These instruments are especially useful in the ligation of large deeply situated vessels such as the common iliacs, the innominates (vein and artery) and the left subclavian and carotid arteries within the thorax. The fine thread serves as a leading string for the tape with which we ligate large arteries.

FIG. 3.—Aneurism-needle employed in ligation of the inferior thyroid artery.

FIG. 4.—Mosquito clamp carrying one of the semicircular aneurism-needles; unfortunately, it has lost its original delicate form in the hands of successive instrument makers.

FIG. 5.—This clamp was a decided departure from the forms in use at the time it was designed, about 30 years ago. Except for a modification in the beak it is essentially the same as the clamp made for me in 1878 by Otto and Reiner of New York. The broken off cambric needle in its jaws is a ligature carrier—a form of aneurism-needle we frequently employ.

INSTRUMENTS DESIGNED BY THE AUTHOR IN 1888-89 FOR THE JOHNS HOPKINS HOSPITAL.

FIGS. 1 AND 1a.—Two views of a retractor designed for use in the operation of ligating the inferior thyroid artery. The blades should be very thin, thinner than depicted, in order to take as little space as possible in the small, deep wound.

FIGS. 2 AND 3.—Forms generally used in the clinic.

FIG. 4.—Blood vessel retractor.

INSTRUMENTS DESIGNED BY THE AUTHOR IN 1888-89 FOR THE JOHNS HOPKINS HOSPITAL.

3

FIG. 1.—Blunt dissector for arterial work. The operator should use two of these in freeing an artery, an assistant aiding with a third.

FIGS. 2 AND 2a.—Two views of the knife. The handle being hollow is well balanced, and its tip, drawn out to a fine edge, makes an excellent dissector.

FIG. 3.—Taken from Günther's *Lehre von den blutigen Operationen am menschlichen Körper*, Leipzig, 1859, Vol. I, Plate 5, opp. p. 36.

INSTRUMENTS DESIGNED BY THE AUTHOR IN 1888-89 FOR THE JOHNS HOPKINS HOSPITAL.

STUDY OF ARTERIO-VENOUS FISTULA WITH AN ANALYSIS OF 447 CASES

By CURLE L. CALLANDER

This paper is written at the suggestion of Prof. W. S. Halsted, who generously placed at my disposal all the material collected by him in the course of his study of arterio-venous fistula. Dr. Halsted's particular interest in this subject arose from his effort to determine the cause of the proximal dilatation of the artery, which has been observed in a number of these cases, and which he believes occurs invariably.

In his writings he has expressed the view that the dilatation of the artery which is (1) distal to the partially occluding band, (2) beyond the site of coarctation in cases of congenital stricture of the aortic isthmus, and (3) distal to the constriction of the subclavian artery by a cervical rib will be found to have the same cause as dilatation of the artery central to an arterio-venous aneurysm. The subject is discussed in his papers published in the *Journal of Experimental Medicine* *, the *Proceedings of the National Academy of Sciences,* † and in *Surgery, Gynecology and Obstetrics.*‡

Dr. Halsted's interest in the study was further stimulated by the conviction that an arterio-venous fistula may be responsible for the enlargement of the heart that he has repeatedly observed as a complication in these cases, and which Dr. Mont Reid, at his suggestion, has attempted (and with success) to prove.

* An experimental study of circumscribed dilatation of an artery immediately distal to a partially occluding band, and its bearing on the dilatation of the subclavian artery observed in certain cases of cervical rib. —W. S. Halsted.

Partial occlusion of the aorta with the metallic band. Observations on blood-pressures and changes in the arterial walls. Mont R. Reid. *Jour. Experimental Medicine*, 1916, xxiv, 271.

† Dilatation of the great arteries distal to partially occluding bands. *Proc. of the Nat. Academy of Sciences*, 1918, iv, 204.

‡ Cylindrical dilatation of the common carotid artery following partial occlusion of the innominate and ligation of the subclavian. *Surgery, Gynecology and Obstetrics*, 1918, xxvii, 547.

I wish to acknowledge my indebtedness to Dr. Halsted's secretaries, Miss Hough and Miss Stokes, for their valuable assistance in abstracting case reports.

This study is carried to the year 1914, but, in addition, reviews all the cases recorded among the surgical histories of The Johns Hopkins Hospital, as well as a number of selected instances appearing in the surgical literature of the recent war.

I. History of Arterio-Venous Aneurysm

To William Hunter undoubtedly belongs the credit of first describing accurately not only the clinical features, but also the disturbed mechanism of the vascular physiology of arterio-venous fistula. This he did in 1757, and this analysis was followed in 1762 by the detailed publication of the two cases which formed the basis for his description and conclusions.

An excerpt from the account of his first case reads:

> About 14 years ago a lady was bled in the basilic vein of the arm by a surgeon who was unfortunate enough to wound the artery through the sides of the vein. He was instantly sensible of the misfortune by the violence of the stream that gushed from the vein. At the time of the accident, and for a great while afterwards, every method that could be suggested was taken for preventing or curing an aneurysm by compression.
>
> The veins in the bending of the arm and especially the basilic, the vein that had been opened, were prodigiously enlarged at that place and came gradually to their natural size about 2 inches above and as much below the elbow. When emptied by pressure they filled again almost instantaneously; and this happened even when a ligature was applied tight about the forearm immediately below the affected part. Both when the ligature was made tight and when it was removed they shrunk and remained of a small size, while the finger was kept tight upon the artery, at the point where the vein had been opened in bleeding. There was a general swelling and fullness at the affected part, and in the course of the artery, which seemed to be larger and to beat stronger than what is natural all the way down the arm. There was likewise a pulsation in the dilated veins, corresponding to the pulse in the artery; and there was a hissing sound, and a tremulous jarring motion in the veins, which was very remarkable at the part which had been punctured, and became insensible at some distance both upwards and downwards.
>
> Though such a case has never before entered my thought, I was so well convinced by the symptoms of its arising from a communication between the artery and the vein that I gave an opinion to that purpose and therefore advised her to do nothing while there should be no considerable alteration.

The following extract concerns Hunter's second case:

A male who was bled in the arm about five years previous to the examination.

The trunk of the brachial artery is considerably enlarged all the way down the arm, and its pulsation so strong that it is apparent to the sight. A little above the bend of the arm the artery makes a remarkable serpentine turn, which raised up the skin and by the force of the pulsation looks as if it was a beginning aneurysm. But notwithstanding the size and force of pulsation of the brachial artery be much more considerable than in the other arm, the artery at the wrist is much smaller, and its pulsation much weaker. Whence it is evident the disorder has brought on a great disproportion in size between the dilated trunk and the shrunk branches of the artery of the diseased arm.

At that place where the puncture was made, a bag rises up projecting as much as if it were a large nutmeg under the skin. This bag is filled entirely with fluid blood, disappears under pressure, and has a strong pulsation. Its deepest part is manifestly united with the artery. Over the inside and the most prominent part of this bag, the basilic vein runs, and is so firmly united to it and blended with it by communication that it is difficult to determine whether the bag be a sinuous dilation of the part of the vein or if it be an adventitious cavity between the artery and vein formed in the cellular membrane; though I am more inclined to believe the last. Its communication, however, both with the artery and vein is undoubted, as will appear by what follows.

The basilic vein is very much enlarged and its extension is very apparent and makes a considerable external swelling. But when the arm is held up so as to give the returning blood the advantage of running downwards, the vein subsides and no swelling whatever appears, except just at the punctured place, where the bag continues nearly as much dilated as when the arm hangs down.

There is a remarkable tremulous motion (as well as considerable pulsation) both in the bag and in the dilated vein as if the blood was squirted into it through a small hole. It is like what is produced in the mouth by continuing the sound of the letter "R" in a whisper. It is the strongest at the very place where the vein was punctured, and becomes gradually less perceptible from that part upwards. It is even very apparent to the sight. It is entirely stopped by pressing the trunk of the artery anywhere above, or by pressing the bag or the vein at the punctured part, and there the very point of the finger is of sufficient breadth for the purpose. These compressions instantly stop the tremulous motion, and it instantly returns again when they cease. It is the same when the arm hangs down, and when held up; and when loose and girded by a ligature below the punctured part.

This motion is not only felt and seen distinctly, but heard if the ear be held near the part; and if the ear touches the skin the sound is much more loud and distinct. It is a hissing noise, as if there was a blast of air

through a small hole, and interrupted, answering precisely and constantly to the stroke of the heart or the diastole of the artery. It stops immediately when the trunk of the artery is compressed and returns instantly when the artery is free. The patient is so sensible of the noise that he often finds that it keeps him from falling to sleep, when the arm happens to be near his head, and then commonly puts it down by his side in bed that he may go to rest.

If one looks with attention while the compression is taken from the artery, you can trace the blood rushing first down the artery, then across the bag, and last of all, flying upwards in the vein.

Guattini, an Italian, who in 1785 published an accurate description of this type of aneurysm, was by Scarpa given joint credit with Hunter for the discovery. Eighteen years, however, had elapsed between Hunter's report and that of Guattini. Moreover, in that interval Cleghorn, White and Armiger had each published detailed descriptions of arterio-venous aneurysms of the brachial vessels.

To Sennert, too, different authors have unfairly attributed the credit of this discovery, but he, as did other foregoing observers, misconstrued undoubted cases of arterio-venous fistula as cases of simple arterial aneurysm.

It is interesting to note that this discovery did not take place until the middle of the 18th century, after the lancet mode of venesection had been in vogue for years. Since it had been practised in many instances by men little versed in the arts of anatomy and surgery, it follows fairly logically that simultaneous wounds of the artery and vein were fairly common long before the discovery was made. If the phenomena consequent upon the union of artery and vein were present, they were mistaken for evidences of arterial aneurysm.

New observations followed at an early date, but Delacombe in France published the first case of arterio-venous aneurysm in which the clinical findings were confirmed by the lesions found at autopsy.

The later theses of Morvan, Goupil, Henry and others, together with a monograph by Delbet and a paper by Bramann, have done much to clear up the various phases of the clinical and pathological pictures.

II. Classification

Definition of Arterio-Venous Aneurysm.—By arterio-venous aneurysm is meant any pathological union between an arterial and a venous channel, whether that communication exists between a systemic artery and vein, between an artery and a venous sinus, or between the aorta

and the right ventricle, the right auricle or the pulmonary artery. These communications fall naturally into different varieties according to certain definite changes in form and structure obtaining in the various parts of this complex.

Aneurysmal Varix.—The simplest form of such communication is that in which no saccular dilatation true or false springs from the artery, vein or channel of communication. This variety was called by Broca *phlébartérie simple,* but in the general, more confusing momenclature, bears Cleghorn's designation, *aneurysmal varix.* Here the wounds of the artery and vein are approximated and become agglutinated with a single orifice of communication. In addition, there is a gradual dilatation of the vein. This tumor is *aneurysmal,* having communication with the arterial circulation, and because of its venous dilatation is designated as *varix.*

The anatomic factors governing the formation of this type of aneurysm are: The proximity of the involved vessels, the space afforded them in the vascular cleft, and the amount of support given them by the surrounding tissue (Makins).

Varicose Aneuryism by Dilatation.—When the vein increases in size and bellies out into a circumscribed swelling, and when that dilatation involves only the walls of the expanded vein, the resulting aneurysm was called by Broca *varicose aneurysm by dilatation.* It seems arbitrary, however, to distinguish between this type and that which constitutes aneurysmal varix, for one may readily pass from the one into the other by the most insensible gradations.

Encysted Varicose Aneurysm.—In another group of cases, the details of the injury are such that either artery or vein, or both artery and vein are transpierced, affording channels for arterial or venous extravasations into the tissues. Although the edges of the arterial and venous wounds destined to form the fistulous communication may early become approximated, the other vascular wound or wounds may remain patulous. In this instance a false aneurysmal cyst or cysts, with walls formed from perivascular tissue and laminated clot, will occur at the unhealed sites of injury, and it is the connection of these false circumscribed sacs which furnishes the basis for subdivisions of this variety. When the cyst of new formation surmounts the vein, the *encysted varicose aneurysm* is designated as *venous;* but when this sac rests singly on the artery, the aneurysm is known as *arterial encysted varicose aneurysm.* When false aneurysmal cysts are noted

upon both the artery and the vein, the resulting rare aneurysm is termed *double arterial and venous encysted varicose aneurysm.*

Intermediate Encysted Varicose Aneurysm.—In a certain group of cases where a profuse extravasation of blood has occurred at the point of injury, so situated as to separate the artery and vein and to prevent their adhesion and union, and forming a false aneurysmal sac which serves as a channel of communication, the tumor is known as an *intermediate encysted varicose aneurysm.*

Were the above condition to appear combined with a superimposed false sac on either the artery or the vein, the complex is known as *double arterial or venous intermediate encysted varicose aneurysm.*

To Cruveilhier, in 1853, we are indebted for the essential features of the above classification.

Arterio-Bi-Venous Aneurysm.—A very rare type of aneurysm in which an artery has a fistulous communication with two veins may be designated as *an arterio-bi-venous aneurysm.* Such anatomic relations existed in Park's brachial and Mignon's axillary fistula.

Chauveau reported an arterio-venous aneurysm of a most curious variety, occurring on the jaw of a horse embracing the muscular maxillary artery and vein. From this thin and dilated artery, there arose five or six large flexuous branches, ampulliform at their origins, making large mutually anastomosing ramifications on the walls of the venous sac. Definite communication existed between these arterial anastomoses and the dilated *vasa vasorum* in the wall of the varicose vein, and these again communicated directly with the main channel of the vein. This complex Chauveau describes as an *arterio-venous aneurysm by dilatation of the vasa vasorum of a varicose vein.*

III. Etiology

The predominating cause of arterio-venous aneurysm is some form of traumatism. The detailed table of causes given below will show that in a total of 447 cases 383, or 85.7 per cent resulted from injury.

189 Projectiles:
- **166 Bullet.**
- **2 Bomb.**
- **5 Shrapnel.**
- **9 Shell.**
- **6 Piece of metal.**
- **1 Grenade.**

161 Knife wounds:
38 Venesection.
123 Cuts and stabs.
28 Contusions.
5 Fractures.
20 Secondary aneurysm.
7 Doubtful origin.
3 Congenital.
34 Unknown.

447 Total.

Of the main traumatic factors, wounds from projectiles and knives played about an equal rôle, 189 cases resulting from the former and 161 cases from the latter.

Bullet Wounds.—The bullet was the causative factor in 166 instances, and its more extended use in modern warfare has made arterio-venous aneurysm as familiar now as it formerly was from promiscuous venesection.

In the earlier wars, the occurrence of arterio-venous aneurysm from bullet wounds was rare, for among 400 vascular injuries in the service of Demme in the North Italian Military Hospital in 1859 not one single case of arterio-venous aneurysm was reported; nor were any noted in the Crimean War. Only 8 cases were reported from the Franco-Prussian War in 1870-71. In this regard, Küttner remarked that aneurysms were usually associated with injuries of large arteries, and their occurrence was infrequent in those wars because of the larger wounds and the frequent hemorrhages. In modern warfare, however, conditions are exactly the opposite and aneurysms constitute a very interesting class of war wounds.

According to von Bergmann, arterio-venous aneurysm results from the clean, narrow puncture so liable to occur with the rapidly formed, penetrating wounds caused by the small calibre bullet. The conditions associated with the formation of traumatic arterial aneurysms are identically those required for the production of the arterio-venous variety, namely: a small orifice of entrance and exit for the bullet, a narrow but long, curved channel usually crossing the course of the vessels in an oblique direction, a small perforation in the artery, followed by rapid closure of the wound and primary union of the bullet's track.

Such conditions prevailed during the more recent and the present wars. In the official report from the surgical cases noted in the South

African War, 1899-1902, Surgeon General Stevenson of England reported 63 cases of traumatic aneurysm, of which 33, or almost 50 per cent, were of the arterio-venous variety. Saigo, writing on traumatic aneurysms in the Russo-Japanese War, found approximately the same proportion.

A variety of *bomb, shrapnel and grenade wounds* account for 23 additional cases. It is interesting to note the increasing frequency of arterio-venous aneurysms caused by explosives since Bramann in 1886 gave his excellent analysis of 159 cases in which only 29, or 18.2 per cent, resulted from this general source. In our series of 447 cases, 189 were caused by injury from projectiles, making a total of 42.2 per cent. The incidence of arterio-venous aneurysm in the later decades is noticeably greater.

Cut and Stab Wounds.—Cut and stab wounds, including injuries by lancet, knife, stake, chisel, bayonet and spike, are responsible for 161 aneurysms, or 36 per cent.

Arterio-venous aneurysm resulting from venesection has in recent years become of comparatively rare occurrence, for indiscriminate and inefficient bleeding has ceased to be a practice of modern medicine, and the unintended consequences of the measure have therefore ceased to be frequent. Among Bramann's collection of 159 cases 56, or 35.2 per cent, resulted from venesection. In Delbet's series of 250 aneurysms, 92 cases, or 36.8 per cent, resulted from this source. In 447 cases in this series only 38, or 8.5 per cent, followed venesection.

Contusion.—The 9 cases falling under the heading of contusion are made up indiscriminately of injuries no more specific than blow, fall, trauma, injury and wound, and include an aneurysm, reported by Robinson, in an amputation stump of the knee.

According to Matas, the aneurysmal varices occurring in amputation stumps are usually associated with massive ligatures of both vessels followed by infection.

Fracture.—Fracture was the traumatizing agent in the injury of the vessels in the following five cases: Cushing's aneurysm of the internal carotid artery and the internal jugular vein from a fracture of the skull; Gross and Sencert's fistula of the anterior tibial vessels from a fracture of the leg; Reboul's subclavian aneurysm from a fracture of the clavicle; Findlay's femoral aneurysm from a fracture of the femur; and Bornhaupt's aneurysm of the brachial vessels from a fracture of the humerus.

Secondary Aneurysm.—There is a group of 20 secondary arterio-venous aneurysms which followed the erosion into neighboring venous channels of preexisting arterial aneurysms of the ascending and the abdominal aorta.

Congenital.—In 3 cases the fistulae were present from birth. Sir Prescott Hewitt reports an arterio-venous aneurysm of the common iliac vessels in a hydrocephalic in whom the right thigh at birth was larger than the left, and the superficial veins of which were engorged. In Busche's temporal fistula a pulsating tumor the size of an egg had existed since birth. In Halsted's aneurysm about the external carotid artery a buzzing and throbbing in the right side of the neck was noticed when patient was three days old.

IV. Pathology and Pathological Physiology

Venous Dilatation.—An ever-increasing dilatation of the vein about the fistulous communication is one of the most constant features of arterio-venous aneurysm. This dilatation may be more or less uniform and may extend over a considerable portion of the whole vein, or may be at its maximum at the point of communication. The fundamental cause of these venous changes is the increased pressure in the veins produced by the passage in them of arterial blood.

Normally, the pressure of the blood in the veins is slight, and the venous blood in them is carried by the *vis a tergo* communicated through the capillaries, aided by such other influences as the pressure of the contracting muscles, the changing position of the limbs, and the suction exerted by the thorax during the inspiration. The numerous valves placed along their course preserve each advance as it is made, and protect the underlying vessels from the extension to them of any accidental increase in the trunk above.

When arterial blood passes directly from an artery into its corresponding vein, it does so under a pressure which far exceeds the normal blood pressure in that vein, and, since it cannot escape toward the heart without lifting and rapidly pushing before it the venous column on the proximal side, the increased pressure must be exerted on the lateral wall of the vein. Under such increased pressure the wall of the vein yields and its lumen enlarges. So long as the calibre of the vein increases and the vein valves distal to the communication remain sufficient, this added arterial pressure is not transmitted directly into the column of blood in the peripheral vein but merely

obstructs its central passage to the heart by imposing an obstacle against it. When, however, the valves yield under the pressure, or become insufficient from the enlargement of the vein, and the arterial pressure is transmitted against those segments thus deprived of protection, the same changes in turn occur in them and a consequent dilatation of the vein ensues.

Pressure conditions peculiar to the internal jugular vein and other large veins of the neck account for a marked abnormality in that region. Stimson was the first to note that in the internal jugular vein the blood, instead of being pushed by the *vis a tergo,* is being pulled or drawn along by the *vis a fronte,* the strong suction of the chest at each inspiration, and the feebler one of the elastic return of the lung upon itself during expiration. Instead of being distended, the wall of the vein is habitually flaccid, and the pressure in it is low or even negative. In addition, its lumen is very large and it communicates within a very short distance with other trunks whose lumina are as large as its own, in which also the pressure is negative and into which, therefore, any excess of blood will readily escape. In other words, if there is an aneurysmal dilatation or sac, it is not large and has no tendency to grow larger. The average internal pressure is low because the incoming blood is no longer confined, but escapes into the vein as readily as it enters from the artery, and is thus prevented from exerting a distending influence on the wall of the dilatation or sac. The change, once established, has no tendency to increase. Stimson's postulate finds ample verification and corroboration in the study of the aneurysms of the common carotid artery and the internal jugular vein occurring in this series.

When, on the other hand, the external jugular vein is involved, and where conditions more nearly resemble those found in the other parts of the body, and where the venous escape to the heart is less free, there is a resulting dilatation of the vein.

The extent and location of the dilatation of the vein are dependent upon several well-recognized factors: First, the size of the communication determines the amount of arterial blood diverted through the fistula exerting pressure on the vein; second, the resistance afforded by the varying denseness of the perivascular tissue; third, the duration of the fistula; fourth, the degree of patency of the central segment of the vein; and, fifth, the influence of gravity.

Venous Hypertrophy.—Although occasional large sacculations may be met with, as a rule the veins support their increased vascular tension to an unexpected degree, owing to the acquired hypertrophy of the muscular coat. This ability of the vein to hypertrophy and to assume the work of an artery is shown in no more conclusive manner than by the admirable experiments of Alexis Carrel, who has demonstrated the feasibility of transplanting a segment of vein into an arterial defect several centimeters long by means of a double end-to-end suture. "Aided by the support of the surrounding tissues and by its own hypertrophy, the interposed segment of the vein, after a temporary slight ballooning, soon effectively plays the part of the thick-walled artery for which it has been substituted." The changed appearance of the vein, due to the hypertrophy of its muscular coat, has been termed *arterialization.*

There has been considerable controversy over the reason for these changes, Breschet alone contending against an explanation on purely mechanical grounds, and considering them the result of chemical changes in their walls wrought by the influx of arterial blood.

Pathological Changes in Vein Valves.—The vein valves, since they play a most important mechanical rôle in protecting the distal venous column from abuse, show important changes. As the lumen of the vein increases and the head pressure from the artery continues, the burden of the valve becomes increasingly heavy, until pair by pair they become insufficient. In Socin's femoral fistula of 19 days' duration, the first set of valves distal to the communication were almost destroyed, whereas the set next below were intact, while with fistulæ acting over a longer duration the valves at a greater peripheral distance fail to function. In Bramann's axillary aneurysm of 1½ years' duration, the valves, as far distally as the opening of the median basilic vein, were insufficient, and an examination of one of them located at some distance from the fistula showed one segment much shrunken, forming a ridge in the lumen of the vessel, with the other torn and lying adhesed to the side of the vein.

Rokitansky pointed out that valvular hypertrophy took place below that point in the distal segment of the vein where a moderately increased but continuous arterial pressure was maintained. This feature is illustrated in Rokitansky's own axillary aneurysm and Robert's femoral aneurysm.

According to Matas, the resistance of the valves favors the dilatation of the vein in segments, forming tumors which vary from the size of a pea to that of a large egg, or even of a fœtal head.

Changes in the Internal Saphenous Vein.—It is important here to make certain observations relative to anatomic characteristics peculiar to the internal saphenous vein, such as the extraordinarily strong valves at its mouth, and an absence of anastomosis with the deeper veins. J. Gay and W. Braune have demonstrated that but one small anastomosis exists between this long saphenous vein and the deep veins of the thigh. Because of these findings, there are here remarkably few instances of the pathological changes found elsewhere. In three cases, femoral aneurysms only—those of Pemberton, Gallerand and Davies-Colley—did dilatation and hypertrophy occur.

Bone and Calcium Deposits About the Fistula.—At various stages in aneurysm formation unusual bone and calcium deposits have been noted on the walls of the sac in the immediate vicinity of the fistula. Zoege von Maneuffel reported an ossified varicose aneurysm of the femoral vessels of only four weeks' duration, which communicated directly with the marrow cavity of the femur. Gallerand's femoral aneurysm was found to be hard and cornified throughout and intimately attached to the femur; it contained numerous phleboliths which the author asserted were mere fibrinous clots which had undergone calcium metamorphosis. The sac wall of Trélat's popliteal aneurysm was semiflexible, thick and resistant, and as difficult to cut as a piece of leather, while its internal surface was studded with calcified and atheromatous plaques. In Beaumont's aneurysm of the femoral vessels, a small deposit of calcareous material was noted in the laminated fibrin suspended in the sac. Intramural calcium deposits were seen in the femoral aneuryisms of Perry, von Wahl, and Eisenbrey.

Organized laminated clot within the aneurysm, though rarely seen, has been reported in the cases of Beaumont and Eisenbrey.

Proximal Dilatation of the Artery.—Hunter, in 1762, recognized the dilatation of the artery proximal to the fistula in his two cases and attributed it to the lessened work which the artery was called upon to perform.

According to Hodgson, "The enlargement of the artery above the tumor appears to be the effect of that property by which the size of arteries becomes adapted to that of the parts which they supply.

The stream of blood, which at each pulsation of the heart passes through the wound into the vein, is so much taken from the supply intended for the nourishment of the limb. To compensate for the stream which passes through the wound in its coat, the main artery enlarges in the same manner as an artery becomes dilated to supply a præternatural growth."

Broca concluded that the lessened arterial pressure, which resulted from the deviation of blood through the fistula, called to the part a larger quantity of arterial blood, and he subscribed to the physiological teaching that the calibre of the vessel, other things being equal, places itself in harmony with the amount of blood which traverses it.

According to Bourges, the proximal artery loses its tone and resistance as a result of vasomotor change, while the thinning of its walls is a result of malnutrition due to some inherent change in the blood caused by the diminished pressure, on the basis that functional inertia may result in nutritive alterations.

The dilatation and thinning of the artery, according to Delbet, are to be explained on the basis of disuse atrophy, since the artery in the presence of the fistula needs no longer to contract against the customary arterial pressure.

Breschet explains the phenomena on the assumption that venous blood traverses the fistula and enters the artery during the period of cardiac diastole. Without placing any reliance on this hypothesis, it is well to note Franz's experimentally produced fistulæ in dogs in which he ascertained that occasionally the venous pressure about the fistula may exceed that of the arterial.

It has been stated by some that the central dilatation of the artery varies directly in size with the duration of the fistula. In Gripat's brachial aneurysm, with a duration of 42 years, the subclavian artery had attained the volume of the abdominal aorta; there are, however, numerous instances of long duration in which the artery is little or not at all enlarged.

Delbet attaches some importance to the age of the patient, noting that in the cases of Adelman, Selenkow, Perry, Rokitansky, and Broca, the patients were more than 40 years old.

What has been said concerning this fairly constant phenomenon, the proximal dilatation of the artery, perhaps justifies the collection of detailed descriptions of this feature, listed according to author and location. In the 447 cases in this series this characteristic was noted in 57 instances, giving a percentage total of 12.7.

TABLE OF PROXIMAL DILATIONS

Author and case No.	Location of fistula	Duration of fistula and description of proximal dilatation
Rokitansky (85).	Axillary.	Duration of fistula, 33 years. Proximal dilatation of axillary artery.
Osler (100).	Axillary.	Duration of fistula, 30 years. Proximal dilatation of axillary artery in region between the thoraco-acromial and internal mammary arteries.
Hunter (140).	Brachial.	Duration of fistula, 5 years. "Marked proximal dilatation of brachial artery with visible pulsation. Above bend of arm the artery makes remarkable serpentine turn which raises up the skin and resembles a beginning aneurysm. Artery at wrist much smaller than that on opposite side."
Cleghorn (141).	Brachial.	Duration of fistula, a few weeks. "Humeral artery seems considerably enlarged, and pulsation is visible from axilla to elbow."
White (142).	Brachial.	Duration of fistula, 10 years. Brachial artery much enlarged proximally.
Adelmann (147).	Brachial.	Proximal dilatation of brachial artery.
Roux. Obs. 1 (156).	Brachial.	Duration of fistula, 6 years. "Brachial artery above elbow attained considerable size, and its walls greatly thinned. Over whole artery in upper arm to axilla the artery was almost size of middle finger, with almost aneurysmal dilatation. Size of arteries not sensibly larger than normal."
Roux. Obs. 2 (157).	Brachial.	Duration of fistula, 18 months. Proximal dilatation of brachial artery.
Broca (167).	Brachial.	Duration of fistula, 16 years. "During last few years artery dilated to extraordinary degree. New aneurysm, distinct from that on elbow, developed on brachial artery on middle of arm. Axillary and brachial arteries so dilated could not be compressed. Dilation of arterial system reached to innominate artery, because right common carotid artery was much more voluminous than left. Axillary artery larger than aorta and walls very much thinned. An arterial fusiform aneurysm size of hen's egg was at point of amputation."
Gripat (178).	Brachial.	Duration of fistula, 45 years. "Strong pulsations of subclavian artery, which appears size of normal aorta. Collapsed brachial artery measures 13 mm. above sac, where it is very atheromatous, and 8 mm. below where it is flexible."

TABLE OF PROXIMAL DILATIONS.—CONTINUED

Author and case No.	Location of fistula	Duration of fistula and description of proximal dilatation
Warren (205).	Hand.	"Arteries size of the carotids and so dilated as to form what might be called sinuses."
Seger (225).	Femoral.	"Proximal dilatation of femoral artery."
Perry (226).	Femoral.	Duration of fistula, 4 years. "External iliac arteries, especially the left, were extremely tortuous, being reflected upon themselves in a singular manner, during their course towards their crural arch, a condition which had, no doubt, given rise to impression of artery being very dilated, since it conveyed to hand simultaneously the combined pulsations of the folded portions. Coats of femoral were no thicker than those of a vein, the attenuation having taken place equally in all its coats."
Horner (228).	Femoral.	Duration of fistula, 4 months. Artery had appearance of a dilatation.
Baker (229).	Femoral.	Duration of fistula, 5 years. Profunda artery greatly dilated distal to fistula. Femoral artery normal.
Pemberton (236).	Femoral.	"Right external iliac artery dilated, twisted and tortuous."
Cordonnier Obs. 2 (238).	Femoral.	Duration of fistula, 23 years. "Artery slightly flexuous above aneurysm; below, its caliber was normal."
Cordonnier. Obs. 3 (239).	Femoral.	Duration of fistula, 15½ years. "Proximally one feels the femoral artery much larger than on the opposite side. Moreover it is flexuous and forms a sort of italic *S*."
Beaumont (241).	Femoral.	Duration of fistula, 11 years. On proximal side of aneurysm superficial femoral artery was greatly dilated, admitting two index fingers; on distal side, it was much contracted. Common femoral and external iliac arteries on their whole course were equally dilated, but somewhat thinned and otherwise healthy. External iliac arteries also greatly lengthened and thrown into a large curve.
Brindejonc-Tréglode (242).	Femoral.	"Above tumor femoral artery seems to be very large but healthy. Below, caliber is much smaller than in other leg."
Hulke (248).	Femoral.	Duration of fistula, 3 years. "Femoral artery dilated proximally."

TABLE OF PROXIMAL DILATIONS.—CONTINUED

Author and case No.	Location of fistula	Duration of fistula and description of proximal dilatation
O'Grady (254).	Femoral.	Duration of fistula, 15 years. "At operation femoral artery found to be as large as man's middle finger, and the coats thin and unhealthy. External iliac artery resembles abdominal aorta in size. Distended and tortuous, it resembled a sausage in size, with the appearance of a coil of small intestine."
Banks (262).	Femoral.	Duration of fistula, 6 years. "Artery above point of communication somewhat enlarged, and as it neared venous opening increased in size and slightly sacculated, having a blind pocket which would hold a pea."
Gallerand (263).	Femoral.	Duration of fistula, 22 years. "Little below crural arcade on internal surface is a well-marked dilatation, about as large as a cherry, which constitutes a veritable aneurysm by dilatation. Below tumor popliteal artery is diminished in caliber, and has undergone a sort of 'desartérialization.' Femoral artery just above fistula was not enlarged."
Schwartz (267).	Femoral.	Duration of fistula, 9½ months. "Examination of artery above tumor shows that artery is beginning to dilate."
Davies-Colley (271).	Femoral.	Duration of fistula, 5 years. "Diameter of artery at upper end of wound was about ⅝ inch. Opposite to middle of incision it widened to almost an inch, and from being cylindrical above it was here marked by a shallow longitudinal groove as if it were about to divide, but lower still became again cylindrical, and diameter was reduced to ½, or a little more. In size and color resembled a congested piece of small intestine."
Decamps (272).	Femoral.	Duration of fistula, 16 years. "Femoral artery thinned, is dilated to site of collateral on which sac is found. Below the caliber is slightly diminished."
Roberts (282).	Femoral.	Duration of fistula, 6 years. "Femoral artery hypertrophied with small sac on it. Common iliac and external iliac arteries on affected side twice as large as those on other side."
Potherat (291).	Femoral.	Duration of fistula, 7 years. "Artery presents at site of communication a sacciform dilatation. This part of artery is very thin. Arterial trunk is dilated above and contracted below."

TABLE OF PROXIMAL DILATIONS.—CONTINUED

Author and case No.	Location of fistula	Duration of fistula and description of proximal dilatation
Graves (308).	Femoral.	Duration of fistula, 6 years. "Artery in upper part of Scarpa's triangle, and for 2 inches above Poupart's ligament was thinned, dilated, sacculated, and evidently diseased."
Osler (315).	Femoral.	"Femoral artery is greatly dilated."
Heuer (336).	Femoral.	Duration of aneurysm, 18 years. Dilatation of external iliac artery with artery above fistula size of index finger. Thin-walled sac on artery. Hypertrophy and dilatation of heart with mitral insufficiency and auricular fibrillation.
Halsted (367).	Femoral.	Duration, 8 years. Sacculation on the artery opposite the communication. Proximal dilatation of the femoral artery.
Northern General Hospital (364).	Femoral.	Duration of fistula, 16 days. Common femoral artery was slightly dilated.
Horsley Case 1 (368).	Femoral.	Duration of fistula, several months. Femoral artery was greatly dilated.
Horsley Case 2 (369).	Femoral.	Duration of fistula, a few weeks. Artery was moderately dilated.
Halsted (370).	Femoral.	Duration of fistula, 12 years. Marked dilatation of femoral artery. Appears as large as middle finger. Dilatation can be traced well up into common iliac artery.
Brainard (374).	Popliteal.	Duration of fistula, 5½ years. "Branches of popliteal artery were also enlarged as they opened into sac, five of them being large enough to admit a common silver catheter. Coats of artery were thin like those of a vein."
Cock (375).	Popliteal.	Duration of fistula, 11 years. "It is not stated that the popliteal artery was larger than normal but it is said that the popliteal artery was larger going into sac than leaving it. (The deep veins were so extensively thrombosed in this case that arterial blood pressure was probably not much lowered by fistula, and hence there was no dilatation of artery." (W. S. Halsted.)

TABLE OF PROXIMAL DILATIONS.—CONTINUED

Author and case No.	Location of fistula	Duration of fistula and description of proximal dilatation
McLean (378).	Popliteal.	Duration of fistula, 19 years. "Clinically femoral artery appears much enlarged. At operation popliteal artery was enormously enlarged. Texture of arteries was so altered arteries looked and felt like veins."
Fitzgerald (380).	Popliteal.	Duration of fistula, 15 years. "Popliteal artery above aneurysm somewhat dilated. Neither profunda nor the anastomotic arteries had undergone any enlargement. Femoral artery greatly dilated, but external and the common iliacs much more so, having a circumference three times that of the corresponding vessels on sound side. Dilation ceased promptly at upper end of common iliac in a thin walled, prominent sacculus. Elongation and tortuosity were not less prominent than the increase in diameter. Internal iliac, profunda and the circumflex vessels all remained unenlarged." "Noteworthy that superficial femoral vessels were not nearly so dilated as common femoral and iliac vessels, but these are comparatively unsupported, while the former, at least in part of their course, are surrounded by fiber-muscular sheath."
Keyes (381).	Popliteal.	"At autopsy popliteal artery was dilated and thinned."
Lucas-Championnière (383).	Popliteal.	Duration of fistula, 23 years. "Femoral and external iliac arteries remarkably dilated."
von Frisch (415).	Popliteal.	Duration of fistula, 16 years. Femoral artery widened and wall thinned. Popliteal artery not enlarged.
Halsted (390).	Popliteal.	Definite proximal dilatation.
Da Costa (424).	Popliteal.	Duration of fistula, 3 months. "The artery distal to point of fusion was small, and proximal to same point was much dilated, but not saccular."
Gross (435).	Foot.	Posterior tibial artery was nearly as large as femoral. "Another interesting instance of proximal dilatation of artery with naevus maternus with fistula or fistulæ." (W. S. Halsted.)
Faguet (437).	Peroneal.	Duration of fistula, 16 days. Peroneal artery dilated above sac, and posterior tibial artery larger than normal.

TABLE OF PROXIMAL DILATIONS.—CONTINUED

Author and case No.	Location of fistula	Duration of fistula and description of proximal dilatation
Parkman (62).	External carotid.	Enlargement of the common and external carotid arteries.
Fraser (74).	Temporal.	Right occipital and temporal arteries greatly dilated.
Laugier (81).	Posterior auricular artery.	Auricular artery dilated both distally and proximally. Probably is a cirsoid aneurysm.
Bankhart (82).	Facial.	Duration of fistula, 2 years and 5 months. The facial artery above and below the jaw was remarkably tortuous and hypertrophied.
Heuer (61).	Internal carotid.	Internal carotid artery very tortuous.
Halsted (68).	External carotid.	Common carotid artery much larger than usual, but internal carotid artery smaller than normal.

Condition of the Artery Distally.—Unlike the proximal artery where dilatation occurs fairly constantly, that portion of the artery distal to the fistula is usually contracted to much less than its normal calibre. The cause of this is the decreased quantity of blood traversing the vessel in consequence of the loss of so large a portion diverted into the vein through the fistula.

Among the rare instances of distal arterial dilatation may be mentioned the autopsies done by Breschet on the two femoral aneurysms, in which dilatation extended through the main trunks of the arteries into the capillaries. In the present series of cases, excluding those of Breschet, there were but 3 instances in which this distal dilatation was noted. In Cauchois' aneurysm involving the popliteal, peroneal, and the anterior tibial arteries, there was marked distal dilatation of the anterior tibial artery; while in Baker's aneurysm of the femoral vessels involving the profunda artery, this artery was markedly dilated and distended for the first two inches of its length.

Cardiac Complications.—Morvan attributed to Boisseau the first intimation that a cardiac affection may complicate arterio-venous aneurysm. In his fistula of the brachial vessels, palpitation of the heart was noted after the case was well advanced.

The most extreme and progressive myocardial insufficiency, occurring after arterio-venous aneurysm, occurred in two of Halsted's cases

of fistula of the femoral vessels. Up to the time of the accident, the patients had suffered absolutely none of the discomforts of cardiac disease. After the formation of the fistula, however, they became thoroughly incapacitated and suffered at various intervals from symptoms of severe myocardial decompensation, and upon examination exhibited an enormous cardiac hypertrophy and dilatation, together with auricular fibrillation and evidences of chronic passive congestion.

The thickening of the inferior vena cava, which occurred in Eisenbrey's fistula of 18 years' duration, leads one to consider whether this phenomenon, together with the cardiac hypertrophy and dilation which accompanied it, might not presumably be the result of increased venous pressure exerted over a long period of years.

One of the most conclusive instances of myocardial insufficiency occurred in Stewart's patient with femoral arterio-venous aneurysm, in whom, one month following the establishing of the fistula, a systolic murmur was made out over the heart, together with an enlargement of the cardiac outline. A short time after the lateral suture of the artery and vein the heart diminished considerably in size and the murmur disappeared.

Cardiac hypertrophy and dilatation were present in Fitzgerald's popliteal fistula, in Osler's and in Rokitansky's axillary arterio-venous aneurysms, and in Horsley's and in Baker's femoral fistulæ.

V. Symptomatology

Murmur.—The murmur of arterio-venous fistula is continuous in character, reinforced in intensification with each heart systole, and is propagated in the main in a central direction along the vein, becoming increasingly faint as one recedes or proceeds from the communication. It is heard with maximum intensity immediately over the communication, a circumstance which is a valuable indication as to the exact site of the fistula.

Broca and Henry agreed that the cause of the murmur lay in the vibration of the communication when its borders were set into motion by the continuous passage of arterial blood.

Burckhardt, as well as Billroth, thought that it was caused by the clashing of the venous and arterial columns of blood flowing in opposite directions. Chassaignac attributed to the sound a chemical origin resulting from the mixing of the venous and arterial blood, and

Hodgson and Richerand based its occurrence on the friction of the blood on the walls of the communication.

The experiments of Chauveau, Weber, and von Wahl confirmed the speculation of Scarpa, in demonstrating conclusively that it, like all vascular murmurs, is of the fluid type, for the occurrence of which conditions are here particularly favorable where blood under a certain pressure from the artery flows into a widely expanded vein.

The individuality of this murmur has called forth descriptions from a large number of writers. Bayer compared it to the forcing of air through a syringe, while to Larrey it had the sound of water streaming through metal tubes. Willaume compared it to the noise of a bellows, while to Seeger it seemed like water rushing over a dam and like the whistling of the wind. Ribes likened it to the noise of a mill race. The French call it *bruit cataire,* and *bruit de souffle à double courant,* while to the Germans it is the *schwirrendes Geräusch.* Burgess describes it as the sound of "a fly in a paper box."

A peculiarity of this murmur is its occasional audibility at a distance without ear contact. In Murphy's and Graves' femoral, and Osler's axillary aneurysms, it was distinctly heard with the ear six inches away from the affected part.

Thrill.—The rough purring thrill is an evidence that the whirling eddies of blood transmit their vibrations to the thin walls of the vessels; like the murmur it is continuous in character, and has a maximum systolic accentuation directly over the fistula, with a gradually diminishing intensity as one leaves the point of communication. It must be remembered that the bruit and thrill are only different aspects of the same phenomenon, translated into the medical tongue according to the sense which perceives it. Hunter characterized the thrill as simulating the forcing of water through a narrow opening, or the continued whisper of the letter "R." It is the *frémissement vibratoire* of the French.

Cleghorn first placed one end of a metal sound between the teeth and held the other over the tumor and thus combined the palpatory and auditory sensations of the thrill. It was seen experimentally that the thrill spreads through the neighboring vessels with varying intensity and is more strongly felt in the central than in the peripheral segment of the vein.

Venous Pulsation.—Venous pulsation occurs when the arterial pulse wave is transmitted to the venous column of blood and is propagated

both peripherally and centrally, together with the murmur and the thrill. From what has been previously said regarding the exclusive anatomic relations of the long, saphenous vein, this venous pulsation is not found on a superficial aspect of the lower extremity when the deep veins of the thigh are involved. Franz, in experimentally produced fistulæ in dogs, noted that the venous pulsation was visible for but a few centimeters in a central direction, but that it could be seen peripherally a great distance from the communication.

Pressure Conditions about the Fistula.—Much light has been thrown on the question of the intravascular tension about the fistula by Ney's experimentally produced aneurysms in dogs. His purpose was to emphasize the great importance attached to the central segment of the vein in sidetracking and hurrying away to the heart the arterial blood destined for the peripheral artery and the nourishment of the limb. He observed that the arterial pressure under normal conditions varied between 111 and 115 mm. of Hg., but found that after the formation of the fistula, the pressures in the proximal and distal segments of the artery were equal, varying between 73 and 107 mm. of Hg. The venous pressure he found normally to be between 9 and 11 mm. of Hg., while with the fistula in operation is showed an average pressure both centrally and distally, between 71 and 105 mm. of Hg., thus establishing a pressure on the venous side but little less than that on the arterial.

Without entering into confusing details, one can say that Franz has proved the existence of four different streams of blood flowing through the fistula; the first, running from the peripheral segment of the artery into the central segment of the vein, the second, from the central part of the artery into the central part of the vein, the third, from the central division of the artery to the distal segment of the vein, and the fourth, from the central part of the artery to the peripheral part of the vein. Bramann's observation of a venous pressure reading of 87 mm. of Hg. in his aneurysm of the axillary vessels is the only evidence of the correlation between animal experiments and fistula in the human.

Phenomena Associated with Venous Obstruction.—A variety of nutritive and other changes is furnished by the obstruction to venous return. The œdematous infiltration and hypertrophy of the extremity in one of the femoral aneurysms of Lannelongue showed a difference in the circumference of the two thighs of 35 centimeters. There occurred

an extraordinary degree of œdematous infiltratiøn with the occlusion of the central segment of the vein in the fistulæ of von Wahl in the femoral vessels, of Simon in the abdominal aorta and inferior vena cava, and of Leflaive in the common iliac vessels. According to Matas, œdematous infiltration and hypertrophy of the subcutaneous connective tissue are followed by the subsequent atrophy of the skin, with histologic changes akin to those which accompany varicose veins, while the skeletal muscles undergo atrophy and degeneration.

In the lower extremity, trophic disturbances have occurred in almost all the cases which have been followed a sufficient length of time. Large and painful ulcers were the points of refractory hemorrhages leading eventually to death in Leflaive's case of fistula of the common iliac vessels; while in the femoral aneurysms of Hulke and Billroth ulceration developed in the course of four years. Absolute incapacity from atrophy and ulceration of the affected member resulted in the femoral aneurysms of Brindejonc-Tréglode.

Spontaneous gangrene of the foot and leg occurred within eight hours of injury in LaGrange's popliteal aneurysm, and although not common, has occurred even after long periods, as was evidenced by the partial gangrene of the hand which took place after 42 years in Gripat's brachial aneurysm.

Hypertrophy of the hair and nails on the affected part has been noticed.

Bone and Calcium Deposits in the Vicinity of the Fistula.—Among the most interesting nutritional disturbances associated with arterio-venous aneurysm, is the effect of such a fistula on bony growth in the vicinity. In certain cases of femoral aneurysm, increased length of bones has been noted. In 1854, Giraldès observed in a grown man an arterio-venous aneurysm of 14 years' duration, caused by a stab wound in the thigh, sustained in childhood. Careful examination revealed an increase of 3 centimeters in length of the affected leg which was explained on the hypothesis of *over-development* due to obstructed venous return, one-third of the increase being attributed to the femur, and the other two-thirds to the tibia, the foot being elongated half a centimeter.

This subject has been commented upon from time to time by later writers, notably Cordonnier. He first stressed the fact that in Giraldès' case, as in an identical one of his own, the injuries causing the fistula were received during adolescence, or the period of life of growing bone.

Other instances of the same phenomenon have been recorded. Gwilm Davis mentions a young boy with a femoral fistula produced several years before, by an accidental wound of the thigh, during an operation for circumcision. This case was brought to him on account of the marked difference in length between the well and the affected leg. As a result of this and similar instances, he questions whether the production of fistula might not be a desirable means of increasing the length of limbs in certain cases of shortening due to hip diseases and other disabilities.

Sir Prescott Hewett reported a congenital varix of the common iliac vessels in a 17-year-old patient, in whom it was perceived that the affected leg was 2 inches longer than its mate. Franz described a case with femoral fistula in which the nutritional changes caused an increase in the length of the member, and remarked that the stimulus exerted on the epiphyseal lines is similar to that exerted in young subjects with osteomyelitic changes during the period of growth.

Concomitant Nerve Injuries.—In the regions of the axillary and the subclavian vessels, the nerves in the vicinity are particularly liable to injury at the time of the formation of the fistula. In this series of cases, nerve injuries were by far most frequent in aneurysms of the subclavian vessels, as for example in the cases of Larrey, Wederstrandt, Veiel, Erdmann, Matas, and Pluyette and Bruneau. In the axillary aneurysms they were present in the cases of Bramann, Durmin, and Quénu.

Changes in Surface Temperature.—Faguet and Franz, in femoral fistulæ, noted an increase in the surface temperature immediately over and about the site of the fistula, while Knaak and Bardeleben in axillary aneurysm, and Henry in a femoral aneurysm, found the surface temperature of those parts peripheral to the fistula decreased. Trélat and Faguet, in aneurysms of the femoral vessels, found the skin temperature elevated at the level of the fistula and decreased below it. The findings of these groups of men were reconciled by Franz's experimental studies which showed an increase in temperature about the fistula, caused by the increased collateral compensation, and a decrease in those parts peripheral to the communication, as a result of the venous stasis.

In general, however, patients complain of a sense of chilliness and cold in the part at or below the region of the aneurysm.

Sphygmographic Tracings about the Fistula.—Sphygmographic tracings of the venous pulsation have at different times been recorded. Ebenau in 1883, and Franz in 1905, both working with aneurysms of the femoral vessels, took tracings of the pulsation in the femoral vein in which was found a definite *anacrotism* with the indenture well up on a broad summit. This anacrotism was interpreted by Marey as the effect of the arterial blood on the peripheral segment of the vein, and the broad summit was explained on the supposition that the blood streaming into the vein requires a longer time to stretch its flabby walls to their fullest dilatation. In varicose aneurysms, the phenomena may be the expression of the effect of the arterial blood on the walls of the sac.

Cerebral Vascular and Neurologic Disturbances.—Weakness, dizziness and headache are often associated with fistula of the large vessels of the neck. In Stimson's and Willaume's aneurysms in this region, there were marked hearing and visual disturbances, while in Joret's aneurysm of the internal carotid artery and the internal jugular vein, there occurred a complete paralysis of the right side of the body, with death from epilepsy 30 months later.

Diminished Peripheral Pulsation.—In various cases with diminished peripheral pulsation, sphygmographic tracings were made over the peripheral segment of the artery which showed what has been interpreted as a diminished arterial flow.

Tardy Appearance of Signs.—A study of this series of cases establishes the fact that in many instances symptoms and signs either appear late, or have not been recognized early. One of the commonest causes for the tardy development of signs is the temporary thrombosis of the vascular wounds. The thrombus may later become dislodged from increased activity or manipulation of the part. With the dislodgment of the thrombus, the fistula becomes patent and the intervascular circulation is restored.

In Cooper's aneurysm of the femoral vessels, the signs made their appearance on the fifth day, while in Robert's femoral aneurysm they were delayed 6 weeks. In Legouest's axillary aneurysm signs occurred in 8 days and in Bardeleben's axillary aneurysm no signs appeared until after two and a half weeks. In the aneurysms of the subclavian vessels the signs on the average were noted after about 6 days. The recording of the varying times of the appearance of signs suggests a lack of uniformity in their observation.

Symptoms Induced by Proximal Compression of the Artery.—Some observers in their careful analyses have noted a peculiar set of circulatory phenomena dependent upon proximal compression of the artery. The most mysterious feature in this connection occurred in Branham's aneurysm of the femoral vessels, in which case proximal compression of the common femoral artery slowed the heart so markedly as to cause its rate to drop from 80 to 35 beats a minute and so to remain until the pressure was released. Compression on the artery on the sound side produced no such effect, while the examination of the heart showed it to be free from any valvular trouble. Associated with the slowing of the heartbeat, dizziness, dyspnœa, and distress were noted. Compression of the proximal femoral artery in Huguier's aneurysm caused syncope, while in Schwartz's aneurysm it produced agitation, cyanosis and intense dyspnœa, all of which disappeared with the cessation of pressure. Pressure on a carotid artery in Beach's patient with temporal aneurysm, produced sensations of dizziness and distress, while slight compression over the subclavian artery in Breschet's aneurysm in that region caused a feeling of discomfort about the right side of the head and in the right eye. Pressure over the tumor in Cordonnier's and Henry's femoral aneurysms elicited a pain in the region of the heart.

Initial and Secondary Hemorrhage.—Although the initial hemorrhage occurring in Rotter's subclavian and in Halsted's and Horner's femoral aneurysms resulted in syncope, the bleeding in most instances ceased spontaneously or as a result of light compression.

The most important factor in its spontaneous arrest is the infiltration by the extravasted blood of the muscular sheaths immediately around the wound canal, leading to its obliteration. Moreover, where severe primary hemorrhage has occurred with the consequent fall in blood pressure, clot formation is favored both at the point of vascular injury and at the wound's external orifice.

When the secondary hemorrhage occurs during the first week after injury it is rarely of any importance, for it is usually little more than leakage from a small wound during the early contraction of the hæmatoma. When there is, however, a rapid extension of the swelling, one must suspect that type of secondary hemorrhage that probably depends upon the defective process of localization which has allowed some part of the limiting boundary of the false sac to give

way. A sudden rise in blood pressure, accompanying increased activity, or perhaps the free movement of the limb, may be its cause (Makins).

Secondary Arterio-Venous Aneurysm.—A special study of the aneurysms arising from the regions of the sinuses of Valsalva, in the pericardial portion of the aorta, is worth while because of the effect they produce on the neighboring organs. They compress, obliterate, and even form communications with the large venous trunks with which the aorta is surrounded, and thus constitute secondary arterio-venous aneurysms of an extraordinary character. They even burrow into the musculature of the heart itself and have ruptured into the right ventricle, right auricle, and pulmonary artery.

We find an occasional example of rupture from some unusual effort or exertion, but these communications have usually resulted from a gradual softening or ulceration of the walls of the sac. The clinical picture is characterized by a sensation of something giving way in the chest, a feeling of faintness, dyspnœa, and palpitation of the heart, and very decided signs of obstruction to the venous circulation. The face is usually livid and bloated; there is wide-spread œdema of the tissues in all the cases in which death does not supervene too rapidly, and the anasarca involves all parts of the body whose veins are distal to the communication. If the aneurysm of the ascending aorta be in communication with the superior vena cava, the œdema of the face and arms stands in remarkable contrast to the normal appearance of the lower half of the body. When, on the other hand, the abdominal aorta and the inferior vena cava are the seat of the fistulous communication, the œdema of the legs and the lower half of the body is in marked contrast with the unswollen condition of the arms. When the aneurysm erodes the appendix of the right auricle, the right ventricle, or the pulmonary artery, the venous system of the whole body distal to the orifice of the communication shows the condition of general anasarca.

VI. Diagnosis

In this period of modern destructive warfare with the inevitably large numbers of concealed vascular wounds, a careful search should be made for all possible pathological intervascular communications; of great aid in recognizing them is the carefully ascertained history of injury over the vascular tracks.

The cardinal symptoms are a loud, continuous, reinforced murmur with a central and peripheral propagation; a purring, reinforced

thrill; and definite venous dilatation and pulsation at the site of injury. When these are present, the diagnosis of arterio-venous aneurysm should present no difficulties.

Differential Diagnosis as to Variety.—According to Francke, the aneurysmal varix appears about three or four days after the injury in the form of a soft, fluctuant tumor, oval in shape and usually about the size of a hazelnut, increasing very gradually in size and which may be obliterated with light pressure.

The varicose encysted type of tumor is harder, firmer, and less fluctuating; and, although made smaller by pressure, it will not altogether vanish. It is irregular in form and its size varies within wide limits; it is not enlarged by the compression of the artery above, or diminished with the elevation of the member.

The varicose aneurysm by dilatation may be differentiated by the fact that the tumor is less prominent, fusiform in shape, soft to the touch, completely disappears on direct compression, and is diminished in size by the elevation of the part.

Differential Diagnosis from other Conditions.—From arterial aneurysm the arterio-venous aneurysm may be readily distinguished. In the arterial aneurysm the murmur is not constant, but when present is systolic in time and therefore intermittent.

In cirsoid aneurysm, the thrill may be absent or barely palpable, while the afferent and the efferent arteries, together with their branches, are all enlarged and tortuous. The murmur, if present, is weak, lacking the systolic accentuation, and pressure above the aneurysm will not cause the murmur or pulsation to vanish. Its general location is about the head, face, and neck, and in vessels of smaller calibre than those in which arterio-venous aneurysms occur. It is always of spontaneous origin, and frequently occurs in association with nævi.

VII. Prognosis

Observers from the time of Hunter until the present have expressed varying opinions as to the prognosis in this affection. The consensus of opinion is that the condition is always embarrassing, often incapacitating, and occasionally leads to serious results.

Prognosis According to Variety.—Some writers have differentiated the severity of the prognosis in accordance with the variety of the aneurysm. According to Scarpa the aneurysmal varix can be borne with impunity if it be not subjected to frequent violent and unusual efforts, whereas the varicose aneurysm tends to enlarge and cause pres-

sure disturbances. Many of the later authors, Bayer, Cooper, Nélaton, Richet, Bardeleben and others have accepted Scarpa's analysis of the prognosis according to variety.

According to Delbet, however, Scarpa meant by his varicose variety only that type of fistula in which the false sac lies between the artery and the vein, namely, in the type known as the *intermediate encysted varicose aneurysm*. The authors mentioned above, however, gave a bad prognosis in all aneurysms possessing any circumscribed dilatation of the artery, the vein, or the channel of communication. In view of the fact that most cases of simple aneurysmal varix sooner or later show saccular dilatation, it is difficult to see how a clean-cut differentiation between these two main varieties may be made.

Francke, Delbet, and Bramann considered the dangers caused by the varix to be as great as those belonging to the varicose type.

Prognosis as to Duration.—The prognosis must be modified by the knowledge that the presence of fistula is not incompatible with long life. Among the cases in which the condition has existed for periods exceeding 25 years, are the following: Schottin's aneurysm of the vessels of the wrist was present for 55 years; Gripat's brachial aneurysm lasted 42 years; Moore's aneurysm of the temporal vessels was present for 36 years; Hunter's brachial aneurysm for 34 years; Gallerand's femoral aneurysm lasted 32 years; Heuer's femoral aneurysm was present 28 years; and Queitel's common carotid aneurysm for 27 years.

Prognosis as to Progressive Danger.—It must be borne in mind that there is a potential progressive danger from enlargement and rupture of the tumor. Sale's aneurysm of the internal carotid artery and the internal jugular vein resulted in a hemorrhage and death in 8 months after a long period of threatened rupture. After a remission of 16 years, a sudden enlargement resulted in gangrene which caused the death of Broca's patient with brachial aneurysm. Rokitansky's axillary aneurysm remained stationary 33 years, after which it suddenly enlarged and necessitated operation, while Gripat's aneurysm of the brachial vessels after a duration of 42 years, developed a sudden enlargement causing gangrene of the fingers. Annandale's aneurysm grew to the size of an infant's head in the short period of 3 months, and an enormous tumor was present within 4 weeks after injury in Czerny's femoral aneurysm. The brachial aneurysm in Park's case enlarged to the size of a fist and finally ruptured.

Gerdy and Broca have insisted on a more serious prognosis with aneurysms of the lower extremity.

VIII. Treatment

non-operative

The development of the treatment of arterio-venous aneurysm from Guattini, in 1785, up to the present date is one of gradual progression. The earlier years were not the years of surgery and the physician's armamentarium was limited to therapeusis, manipulation, and pseudo-operative procedures.

Injection of Coagulating Fluid.—The knowledge that certain chemicals possessed blood-coagulating qualities, and the hope that a coagulum resulting from their use would block off the fistula, led to the injection into the sac of the aneurysm of perchloride of iron. Failure attended its first use in Velpeau's brachial aneurysm, and death followed in Pravatz's brachial aneurysm, in which its use rendered amputation necessary. Although two injections of this chemical cured Jobert's aneurysm, the dangers from gangrene and secondary hemorrhage do not warrant its employment in this type of case.

Galvano-Puncture.—Cures following galvano-puncture may in most instances be attributed, either to the compression which has preceded, or the inflammation which has followed its application. The consequent gangrene from detached emboli and severe hemorrhages and infections, coupled with its rare cures, make its use in the treatment of arterio-venous aneurysm entirely unjustifiable.

Medicinal Treatment.—Possibly the earliest therapy was the application to arterio-venous aneurysm of Valsalva's precepts in arterial aneurysm. This treatment consisted in repeated venesection and purgation, in conjunction with digitalis therapy and scanty diet, in the hope that spontaneous coagulation of blood about the fistula might take place. Such treatment brought no satisfactory results.

Indirect Compression.—Of the bloodless methods of treatment, the varieties of compression, both direct and indirect, have been most extensively and successfully employed. *Indirect compression* is that which is exerted upon the afferent artery and not over the aneurysmal tumor, and has for its purpose the spontaneous coagulation of blood in the aneurysmal sac. Of the different forms of compression, it is the least painful and may be longest continued without interruption. According as the pulsation of the tumor is diminished or made to disappear altogether, the compression is termed partial or total.

Direct Compression.—In instituting direct compression of the *instrumental* variety, a tampon is securely bound immediately over

the orifice of the communication. The intolerable pain and the occasional accidents from trophic disturbances, together with its unreliability, are the main objections to this method.

The adoption of the *digital* variety of direct compression is attributed to Vanzetti of Padua, who cured several brachial aneurysms by this method of prolonged pressure with the tip of the finger immediately over the tumor as near the communication as possible. The treatment was instituted as a means of stimulating collateral circulation in preparation for a future ligation, but it should be remembered that cures have been obtained in but a few brachial aneurysms of very recent origin, and that in some instances it has exposed the tumor to inflammation and rupture with a subsequent gangrene of the part.

In this series of cases compression was attempted in all locations and varieties of aneurysms in 61 instances; 9 patients were cured, 3 died, and in the remainder the procedures were failures. Of the cures, 7 occurred in brachial aneurysms, 1 in Trélat's femoral aneurysm, and 1 in Geschwind's axillary aneurysm.

Guattini, in 1785, using a combination of the direct and indirect methods of compression, has to his credit the first cure of brachial aneurysm. Other cures are attributed to Vanzetti, Monteggio, and Brambilla.

Considerable interest has arisen regarding the possibility of transforming arterio-venous aneurysm into arterial aneurysm by the obliteration of the communicating fistula. In 1809 Scarpa conceived the idea of obliterating the point of communication between the two vessels for he wrote: "In a favorable case in which the exact opening in the vessels may be brought into union against the bony walls, and the pressure here maintained for a sufficient length of time, there is no reason to suppose that the firm mass of the adhesive tissue will not seal off the opening with the resulting cure of the patient." Brown, in 1836, thought that "a gradual, prudent compression in young subjects may bring about an adhesive inflammation which will determine the obliteration of the opening between the artery and the vein." Nélaton, in 1846, first accomplished this result.

Inflammation of the sac is the most common accident resulting from compression. In Spence's case of femoral aneurysm, it necessitated operation and in Carafi's femoral fistula compression on the communication was followed by gangrene. Death following compression was

the outcome in Gallerand's femoral aneurysm, while compression of the abdominal aorta and inferior vena cava in Simon's aneurysm caused peritonitis from intestinal gangrene.

OPERATIVE

Hunterian Ligation.—Hunterian ligation, or the proximal ligation of the artery at a distance from the fistula, was practised in 32 cases in this series, resulting in 5 cures (15.6 per cent), 19 deaths (59.3 per cent), and 8 instances of gangrene (25 per cent). Recurrence constituted the majority of the failures. Three cures of femoral aneurysm were reported by Korlowski and Bickham after ligation of the external iliac artery, and by Freyer after ligation of the common femoral artery. A cure resulted in Stromeyer's popliteal aneurysm.

Deaths from hemorrhage or infection occurred in the femoral aneurysms of Gayet, Lannelongue, Paguet, and Perry, in the brachial aneurysms of Schuh and Piragoff, and in the axillary aneurysm of Rokitansky. Death from gangrene and infection occurred in Socin's and Graves' femoral aneurysms. Deaths from hemiplegia are noted in Prince's aneurysm of the common carotid artery and the internal jugular vein, and Holston's aneurysm of the carotid artery and the external jugular vein. Gangrene caused death in Fitzgerald's aneurysm of the popliteal vessels, and in Robert's femoral aneurysm. Death followed the ligation of the external or common iliac arteries in the aneurysms reported by the following men: Venturoli, Gayet, Roberts, O'Grady, Hutchinson, Lannelongue, Graves, and Faguet. In Bramann's table of 31 Hunterian ligations, only 6 were successful (19.3 per cent). There were 8 cases of gangrene, or 25.8 per cent.

Delbet reported 40 cases treated by proximal ligation, among which there were 10 cures, or 25 per cent; 9 deaths from gangrene, or 22.5 per cent.

Bardeleben has the following to say about gangrene:

If we could by means of asepsis guard against wound infection and inflammation, we should still be unable to regulate the collateral circulation.

According to Matas, there are the following disadvantages to Hunterian ligation:

A. *The liability of gangrene of the limb is increased by:* (1) The interposition of two obstacles to the path of the blood from the cardiac side to the periphery; first at the seat of ligature, and secondly at the site of the

aneurysm, which is totally or partially blocked off by clots after the ligation; (2) by putting out of function a large number of important and often essential collateral branches, given off from the main trunk between the ligation and the aneurysm, in some cases the track of the artery being obstructed by a thrombus for a great part of its length after the ligation; (3) in consequence the blood has to pass through two sets of collaterals before it can reach the part beyond the sac; (4) the risk of gangrene, therefore, increases in direct ratio to the distance between the ligation and the sac; (5) the risk of obstruction of the distal end of the artery by emboli, or propagated thrombi, is greatest in Hunterian ligature, which aims at the gradual and not the immediate suppression of the circulation of the sac, the minor circulation in the sac resulting from previous collaterals which empty into the main trunk above the sac, favoring the increased deposition of active clot, and also breaking up the new, soft, and passive clot, formed temporarily by the ligation of the main trunk.

B. *The re-establishment of the collateral circulation* after ligation at a distance may carry more blood into the main artery between the ligature and the sac, and thus lead to recurrence.

C. *There is no advantage in ligating the artery at a distance* because, (1) the simple aseptic ligature strengthens the artery at the seat of ligation, and there is no secondary hemorrhage when there is no suppuration (2) it has been shown that the arteries are often quite healthy immediately above the aneurysm (especially in the traumatic cases).

D. *The danger of infecting the sac* by the manipulations required to ligate the artery at its termination in the sac is not to be considered in aseptic operations.

Ligation of Anel.—Scarpa was the first to advise the proximal ligation of the artery in the immediate vicinity of the sac as an improvement over the Hunterian ligation. Its advantages are that it shuts off the circulation at once and allows the fluid contents of the sac to drain away completely, allowing whatever laminated clot is present to remain. The volume of the sac is diminished and the tendency is less for the passive clot to break up. (Matas.)

In 16 cases of ligation of this type, there were 7 cures, or 43.7 per cent; 4 deaths, or 25 per cent, and 3 cases of gangrene, or 18.7 per cent. Death from gangrene occurred in Horner's and Bloch's femoral aneurysms, and gangrene in Lewtas' case demanded amputation.

Double Arterial Ligation.—Proximal and distal ligation of the artery in the immediate vicinity of the sac, better known as double arterial ligation, was first successfully employed by Norris, in 1843. Malgaigne, in 1852, and Dupuytren before him, approved the operation. It has been performed 30 times in this series, with 17 cures,

or 56.6 per cent; 3 deaths, or 10 per cent, and 3 instances of gangrene, or 10 per cent.

Hemorrhage and infection were the cause of death in Page's and Cooper's femoral aneurysms and death followed amputation for gangrene in Joyce's femoral fistula. According to Broca, the operation will be successful if the strip of artery between the ligatures contains no collateral branches.

Quadruple Ligation.—Proximal and distal ligation of both artery and vein, or quadruple ligation, has been practised in 27 cases, from which there resulted 21 cures, or 77.7 per cent; 2 deaths, or 7.4 per cent, and 4 instances of gangrene, or 14.8 per cent. Death from gangrene occurred in Pieri's femoral, and in McLean's popliteal aneurysms. Amputation and recovery followed gangrene in Eccles' and Duval's aneurysms of the femoral vessels.

Incision of the Sac.—When the operation of Antyllus, or the incision of the sac, is performed, the afferent and the efferent vessels are first ligated securely outside the sac, which is then incised and its contents evacuated, and a search made for any entering collaterals. If such are found, they are ligated on the periphery of the sac and the cavity is packed.

In 16 cases of this variety, there were 8 cures, or 50 per cent; 5 deaths, or 31.2 per cent, and 3 cases of gangrene, or 18.7 per cent.

While some claim the two advantages of incision of the sac to be the ability to empty the sac of clots and the increased facility for search of the collateral vessels, Delbet considers these advantages of little moment, because clots in the sac are rare, and because the search for the collaterals is really not facilitated. Among the chief objections to the method are the astounding secondary hemorrhages which may result from collaterals so small as to be unsuspected during the operation, and the delayed wound closure from the abandoned sac. Moreover, the calcareous plates, which so often line the sac, act as foreign bodies and interfere by their pressure with the perivascular nutrition, while the danger from disseminated emboli always remains.

Extirpation.—The operation of the complete extirpation of the aneurysm after quadruple ligation of the afferent and efferent vessels, with its high percentage of favorable results, must be duly accredited. In 122 such operations, there had been 117 cures, or 95.9 per cent; 1 death, or 8 per cent, and 1 residual gangrene, or 8 per cent. Death occurred in Barendrecht's case in the popliteal vessels, and failure

resulted in Jaboulay's case of posterior tibial aneurysm. Among the cases of improvement may be mentioned; the popliteal aneurysm operated upon by von Eiselsberg, in which there were residual plaques of gangrene of the foot, and Bornhaupt's aneurysm of the popliteal vessels with residual motor and sensory changes, and von Eiselsberg's brachial aneurysm, which showed symptoms present after three years. In this type of operation, the disadvantages of tardy healing and imperfect hemostasis, as well as gangrene from pressure on arterial collaterals, which in other operations are so major, are here reduced to a minimum. By careful dissection, one may obviate the useless section of adherent nerves and vessels, whose loss plays so important a rôle in the formation of residual nerve and trophic disturbances. In general, it fulfills all the requirements, presents the least danger, and has given up to the present the best results.

CONSERVING OPERATIONS

Most writers agree that the ideal operation is that which maintains the continuity of the vascular paths, and the procedures which serve this purpose are here described under the caption, *conserving operations.* The continuity of one or both vessels may be maintained by three methods: ligation of the communication, lateral suture, and end-to-end suture.

I. *Ligation of the canal of communication* is possible only in cases where the communication is short and easy of access. It has been successfully performed by Cranwell in a popliteal aneurysm, and by Weigel in a brachial aneurysm. Delbet was successful in ligating the communication, but the resulting arterial varix necessitated extirpation. Ligation of the communication with a double ligation of the vein was done in the two brachial aneurysms of Van Ischmoot, and Boddaert & Vercauteren. Ligation of the communication with a double ligation of the artery was successful in Westergaard's femoral aneurysm, and in Erdmann's subclavian aneurysm. This operation was successfully performed by Berkeley and Bonney in an aneurysm of the subclavian vessels, until hemorrhage, which followed suppuration from the replacement of the resected clavicle, necessitated ligation of the innominate artery.

II. *Lateral suture of the artery and vein* has been attempted in 10 cases, up to 1917, exclusive of war statistics, resulting in 8 cures and 2 deaths. The cures are attributed to Veau in aneurysm of

the axillary vessels, Wiesinger and Körte in popliteal fistulæ, and to Ray in an aneurysm of the anterior tibial vessels. Cures in aneurysms of the femoral region are claimed in the cases of Gessner, Stewart, and Halsted. The femoral fistula, located in Hunter's Canal, operated upon by Dr. Halsted was of particular interest. Together with the characteristic symptoms of arterio-venous aneurysm there were exhibited marked swelling of the affected leg and the presence of many healed ulcers. The treatment consisted of lateral suture of the artery and the vein. Heuer successfully sutured the femoral artery and vein in a femoral aneurysm, but was unfortunate enough to lose his patient on the 44th day, from empyema complicating pneumonia, contracted in the hospital. Hemorrhage followed Horsley's double lateral ligature of the femoral vessels, for which a ligation of the external iliac artery was later done, the patient, however, dying from an acute myocardial decompensation.

Lateral suture of the artery and double ligation of the vein has been done in 3 cases. Zoege von Manteuffel, in removing an ossified femoral aneurysm intimately connected with the femur, sewed two rents made in the artery and one in the vein, after which the vein and the tumor were resected. Garrè in a femoral aneurysm, and Doyen in a brachial aneurysm, doubly ligated and resected the vein with the tumor attached after the lateral suture of the artery. Lateral suture of the vein with double ligation of the artery was successful in Montaz's femoral, and Matas' subclavian aneurysms, and in Newbolt's popliteal aneurysm. In Greiss's femoral aneurysm, a double arterial ligation and resection was performed and the segment was used to reinforce the lateral suture of the vein. Improvement resulted from this treatment in Halsted's femoral aneurysm. The one failure occurred in Auvray's ligation of the communication, following a lateral suture of the artery.

End-to-end suture of the artery with the resection of the vein was accomplished by Garrè in a popliteal aneurysm, while end-to-end suture of the artery and lateral suture of the vein was accomplished by Murphy. Godwin performed an end-to-end suture of the vein and a lateral suture of the artery, which latter he reinforced with a segment of transplanted internal saphenous vein. DaCosta, in an aneurysm of the popliteal vessels, made a lateral suture of the artery and an end-to-end suture of the resected vein, reinforcing the lateral suture with the segment of the resected vein.

Preliminary Test of the Collateral Circulation.—The Korotkow blood-pressure test for determining the efficiency of the collateral circulation consists in compressing proximally the artery leading to the aneurysm, and while maintaining this pressure, estimating the blood-pressure in the peripheral circulation, such as the finger. The height of the blood-pressure thus found in the peripheral arterial segment furnishes the true indication as to the adequacy of the collateral circulation. Thus it may be determined whether an obliterative operation may be undertaken.

The advantages and disadvantages of Korotkow's test are aptly illustrated in the axillary fistula of von Oppel. When he compressed the axillary artery in this case immediately above the aneurysm, the blood-pressure reading in the peripheral artery was 40 mm. of Hg. A prognosis of a sufficient collateral circulation was therefore made, and an operation undertaken. It may be said that, near the tumor, two brachial veins opened into a much dilatated axillary vein.

In the first operation, after the axillary artery was divided proximally, the blood-pressure in the finger was found to be zero and the limb became pale. Considering the collateral circulation adequate, however, the wound was closed, but the peripheral pressure did not return, and the forearm and hand blanched. It was then thought that the arterial blood had returned to the heart by way of the beforementioned superficial axillary vein.

In a second operation, this vein was ligated both distally and proximally, but the blood-pressure in the finger still remained at zero. It was certain, then, that some deep accessory vein carried the blood to the heart, for when compression was made in the wound between the stumps of the divided artery, the arm became red and the pressure in the fingers rose to 40 mm. of Hg. It was concluded, then, that some deep vein in the neighborhood of the artery had also been obliterated by digital pressure, and that this vein was the one carrying the collateral blood back to the heart. Further search revealed such a deep vein, which von Oppel now ligated and divided centrally. The pressure in the fingers then returned to 40 mm. of Hg. Following the removal of the bandage, however, the hand again paled and the blood-pressure dropped to zero, a phenomenon which can only be accounted for by the widening of the collateral paths.

Since the collateral paths had widened and diverted the arterial blood to the heart, a third operation was performed on the same day

and the sac was excised entire, with the resulting cure of the aneurysm.

IX. Experimental Arterio-Venous Aneurysm

Amussat, in 1843, was the pioneer in the field of experimental arterio-venous anastomosis, and he produced in horses several varieties of varicose aneurysms. No further experiments on the subject were made, until, in 1878, François Franck studied its production from the standpoint of practical application to the clinical course and symptomatology of the condition. Vignolo in 1902, and Franz in 1905, experimented along similar lines, and the work of the former was the basis of those who followed. San Martin and Satrutegui produced fistulæ on goats and had the courage to use their method in the treatment of 2 patients with senile gangrene, in the hope of opening up new paths to the arterial blood. Both operations, however, were unsuccessful, and amputation became necessary. Stimulated by Jaboulay, Carrel, in 1902, developed his circular arteriorrhaphy, with which he reversed the circulation in various parts of the body and transformed veins into pulsating arteries, and arteries into flaccid veins.

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
1	Thurnam: Med. Chir. Trans., 1840, xxiii, 358 (Case 34).	Art. aneurysm.	.....	Circumscribed aneurysm of ascending aorta eroded into pulmonary artery. Museum specimen. Varicose aneurysm.	.....	Death.	Dil. of aorta.
2	*Ibid.*: Case 37.	Art. aneur.	.....	Museum specimen: True aneur. of ascending aorta projecting into pulm. art. Varicose aneurysm.	.....	Death.	Dil. of aorta.
3	*Ibid.*: Case 38.	Art. aneur.	.....	Museum specimen: Aneur. of sinus of Valsalva, projecting into pul. art. & right ventricle. Varicose aneurysm.	.....	Death.	Fistula smooth & round & showed long duration.
4	*Idem.*: Med. Chir. Trans., 1840, xxiii, 358.	Art. aneur. Male, 33.	Onset during violent exertion. Felt "cracking" about heart. Faintness, palpitation & dyspnœa. Bloody sputum. Jerky pulse. Purring murmur.	Autopsy: Aneur. of rt. ant. aortic sinus, projecting into right ventricle. Varicose aneurysm.	.....	Death after 11 weeks.	Occurred 13 years after rheumatism. Hyp. & dil. of heart. Gen. anascarca.
5	Smith, R. W.: Dublin J. Med. Sci., 1840-41, xviii, 164.	Art. aneur. Male, 21.	General anasarca. Sense of chilliness. Intense thrill & bruit. Increased cardiac dulness.	Autopsy: Varicose aneur. of ascending aorta & pulmonary artery. Edges of fistula rounded, showing long duration.	.....	Death after 3 months.	Attacks of vertigo 3 months before death.
6	Wells: Dublin J. Med. Sci., 1840-41, xviii, 164.	Art. aneur. Male, 54.	Sudden onset with faintness & precordial pain. Cough & hemoptysis. Sense of chilliness.	Varicose aneur. of aorta & pulmonary artery.	.....	Death after 9 hours.	
7	Hope, J.: Hope's Diseases of the Heart, 1842, 437 (1st Am. edition).	Art. aneur. Male, 25 (?).	Sudden onset during exertion. Felt "creak in heart." Jerky pulse. Purring tremor. Cont. rumble. Dyspnœa. Anasarca. Increased cardiac dulness.	Autopsy: Varicose aneur. of aorta & right vent.	.....	Death after 11 weeks.	
8	Munro, D.: *Ibid.* p. 439.	Art. aneur. Male, 24.	Palpitation. Dyspnœa. Anasarca. Increased cardiac dulness. Cont. loud mur.	Autopsy: Varicose aneur. of aorta & pulmonary art. Edges of comm. round & cartilagenous.	.....	Death after 2 weeks.	Rheumatism 10 yrs. before. Cardiac dil. & hyp. Marked sclerosis of aorta.
9	Mayne, R.: Dublin Quarterly J. Med. Sci., 1853, xvi, 257.	Art. aneur. Fem., 50.	Palpitation. Dyspnœa. Inc. cardiac dulness. Suffocation. Giddiness. Jerky pulsation. Systolic heave. Thrill & bruit.	Autopsy: Varicose aneur. of aorta & sup. vena cava. Upper extremities very œdematous: lower extr. free from œdema.	Venesection & leeching.	Death 7 days later.	Dil. of aorta & tributaries of sup. vena cava.
10	Goupil: Thèse de Par., 1855, Obs. 1.	Art. aneur. Male, 28.	Sudden onset. Cyanosis. Œdema. Sensation of cold. Dyspnœa.	Autopsy: Varicose aneur. of ascending aorta & sup. vena cava.	.....	Death.	Previous history: Shortness of breath & palpitation. Sclerosis of aorta.
11	*Ibid.*, Obs. ii.	Art. aneur. Fem., 45.	Sudden onset. Œdema of face & upper extrem. Bruit & thrill.	Autopsy: Varicose aneur. of arch of aorta & sup. vena cava.	.....	Death.	Dil. of aorta. Sense of oppression over heart for 30 years.
12	*Ibid.*, Obs. iii.	Art. aneur. Male, 40.	Sudden onset. Face purple & œdematous. Varicose veins on chest & back. Dysp. & palpitation. Retrosternal thrill & bruit. Stupor.	Autopsy: Varicose aneur. of ascending aorta & sup. vena cava.	.....	Death.	Hyp. & dil. heart.

I. ARTERIO-VENOUS ANEURYSMS OF AORTA AND VENOUS CHANNELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
13	*Ibid.*, Obs. iv.	Art. aneur. Male, 35.	Sudden onset with exertion. Œdema & lividness in upper part of body. Pain in heart & chest. Dysp. & double murmur.	Autopsy: Varicose aneur. of ascending aorta & right auricle.	.....	Death.	Hyp. & dil. of heart. Much palpitation in previous history.
14	Finn, E.: Dublin Quart. J. Med. Sci., 1863, xxxvi, 486.	Art. aneur. Male, 52.	Sudden onset. Dysp. Œdema of face, neck, rt. arm & ⅔ rt. chest in front. Pulse weaker in rt. wrist. Loud & cont. murmur.	Autopsy: Varicose aneur. of ascending aorta and sup. vena cava. Edges of comm. smooth & circular, showing long duration.	.....	Death after 3½ mos.	Rheumatism in early life. Cardiac hyp. & dil.
15	Stokes, Dr.: Dublin Quart. J. Med. Sci., 1871, lii, 249.	Art. aneur. Male, 31.	Anasarca. Dyspnœa. Increased cardiac dulness. Cont. murmur, thrill & bruit.	Autopsy: Varicose aneur. of ascending aorta & right ventricle. Comm. round & size goose quill.	.....	Death.	Dil. & hyp. of heart.
16	Pepper, W. & Griffith, J. P. C.: Bost. M. & S. J., 1890, cxxii, 522.	Art. aneur. Male, 48	Sudden onset. Dysp. Cyanosis of upper pt. of body. Increased cardiac dulness.	Autopsy: Varicose aneur. of arch of aorta & sup. vena cava.	.....	Death.	Hæmoptysis before death. Previous history: Varicose veins 4 mos. on chest.
17	Drysdale, J. H.: St. Barth. Hosp. Rep., London, 1906, xli, 71.	Art. aneur. Male, 56.	Retrosternal dulness increased.	Autopsy: Varicose aneur. of ascending aorta & sup. vena cava & innominate vein.	.....	Death.	
18	Drennen, F. M.: Trans. Chicago Path. Soc., 1912, viii, 322.	Knife. Male, 37.	Tumor below scar from knife wound. Thrill. Cont. murmur.	Autopsy: Varicose aneur. of ascending aorta & sup. vena cava.	Duration of fistula 15 years.	Death from terminal pneumonia.	Cardiac hyp. & dil.

II. ARTERIO-VENOUS ANEURYSMS OF THE COMMON CAROTID ARTERY AND INTERNAL JUGULAR VEIN

19	Willaume: J. compl., du Dict. des sc. méd., 1821, xi, 92. (Pluyette.)	Sword. Male. Right.	.....	Arterio-venous aneur. of common carotid & int. jugular vein.	No treatment. Duration of fistula 45 days.	No change.	
20	Larrey, H.: Clin. Chir., Par., 1829, iii, 149. (Bramann.)	Knife. Male.	Roaring in veins. Dizziness & loss of strength lying down.	Arterio-venous aneur. of common carotid art. & internal jugular vein.	Ice & venesection.	Improvement.	
21	Marx: Arch. gén. de méd., 1834, iv, 135. (Pluyette.)	Sword. Male, 22. Right.	.....	Arterio-venous aneur. of common carotid artery & internal jugular vein.	No treatment. Duration of fistula 8 months.	No change.	
22	Randolph: Am. J. M. Sc., 1847, xi, 13. (Pluyette.)	Sword. Male, 59. Right.	.....	Arterio-venous aneur. of common carotid artery & internal jugular vein.	Anel's lig. com. car. art. 8 months until treatment.	Death.	
23	Prince, D.: U. S. San. Com. Surg. Mem., 1870, i, 147.	Bullet. Male, 20. Left.	Hemorrhage. Thrill. Murmur.	Autopsy: Aneurysmal varix of common carotid & internal jugular vein.	Hunter's lig. com. car. art. 8 days until treatment.	Death after 6 days from hemiplegia.	

II. ARTERIO-VENOUS ANEURYSMS OF THE COMMON CAR OTID ARTERY AND INTERNAL JUGULAR VEIN.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
24	Verneuil: Bull. Soc. chir., 1870, x, 487.	Bullet. Male, 40. Right.	Signs on 2d day. Neck uniformly swollen. Intense thrill. Double bellows murmur, like spinning wheel sound.	Arterio-venous aneur. of common carotid art. & internal jugular vein.	Medicinal & ice.	No change.	No pulsation but dil. int. jug. vein.
25	Queitel: Marseille méd., 1872, 95 et 354. (Pluyette.)	Spont. Male, 40. Left.	.....	Arterio-venous aneur. of common carotid art. & internal jugular vein.	No treatment. Duration, 27 years.	No change.	
26	Sale: Amer. Jour. Med. Sci., 1879. (Bramann.)	Cut. Female. Right.	Tumor. Pulsation. Thrill. Tumor very deep. Rupture of tumor.	Varicose aneur. of com. carotid art. & int. jug. vein.	Tampon. Compression.	Cure.	
27	Bécour: Bull. méd. du Nord, 1884, xxiii, 266. (Pluyette.)	Male, 25. Right.	.....	Arterio-venous aneur. of common carotid artery & internal jugular vein.	No treatment. Duration, 13 years.	No change.	
28	Chapplain: Bull. méd. du Nord, 1884. (Pluyette.)	Knife. Male, 45 Left.	.....	Arterio-venous aneur. of common carotid artery & internal jugular vein.	No treatment. Duration, 67 days.	No change.	
29	Stimson, L. A.: Am. J. Med. Sci., 1884, lxxxvii, 325.	Stab. Male, 25. Left.	Tumor size hen's egg after 4 mos. Whirring & choking sensation. Dizziness.. No venous dil. nor pulsation.	At operation: Aneurysmal varix of common carotid art. & int. jugular vein.	Hunter's lig. com. car. art. 1 yr. & 8 mos. until treat.	Recidive.	
30	Petit, L. H.: Rev. de chir., Par., 1885, v, 239-251. (Bramann.)	Shot. Male, 40. Right.	Bleeding from right ear. Thrill. Swelling. Seeing & hearing dim. Congestion of retinal veins.	Aneurysmal varix of com. carotid artery & int. jugular vein.	No treatment.	No change.	
31	Frusci, F.: Gior. Internaz. d. Sc. Med., Napoli, 1891, n. s., xiii, 41. (Monod & Vanverts.)	Cut. Male, 30.	.....	At operation: "Varicose aneur. by dilation" of common carotid artery & internal jugular vein.	Extirpation.	Cure.	
32	Keen, W. W.: Am. J. Med. Sci., 1892, ciii, 613.	Stab. Male, 16. Right.	Distinct thrill, pulsation & bruit.	At operation: "Varicose aneur. by dil." of common carotid art. & int. jug. V.	Quad. lig. and incision. 3½ months until treatment.	Cure.	Marked dil. int. jug. vein & subclav. vein.
33	Matas, R.: N. Orl. Med. & Surg. J., 1894-5, n. s., xxii, 242. (Monod & Vanverts.)	.....	.....	Arterio-venous aneur. of common carotid artery & internal jugular vein.	Quadruple lig.	Cure.	
34	Jonnesco, T.: Rev. de chir., 1902, 271. (Monod & Vanverts.)	Bullet. Male, 25. Right.	Dysphagia. Dyspnœa. Aphasia. Vertigo. Rt. pupil smaller than left.	Arterio-venous aneur. of common carotid artery & int. jug. vein.	Extirpation.	Cure.	Section of cervical sympathetic. Pupil remained smaller.
35	Morian, K.: Centralbl. f. Chir., 1905, xxxii, 53. (Monod & Vanverts.)	Cut.	Voice and nervous troubles.	Arterio-venous aneur. of common carotid artery & internal jugular vein.	Double lig. com. car. art.	Cure.	

II. ARTERIO-VENOUS ANEURYSMS OF THE COMMON CAROTID ARTERY AND INTERNAL JUGULAR VEIN.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
37	Saigo, K.: Deutsche Zeitsch. f. Chir., 1906, lxxxv, 577. Obs. 2. (Monod & Vanverts.)	Bullet. Male, 22.	.....	At operation: Aneurysmal varix of common carotid art. & int. jugular vein.	Compression. Double lig. com. car. art. 5 months until treatment.	Failure.	
36	Cranwell, J.: Rev. de Chir., 1906, xxxiv, 817.	Bullet. Male, 37. Left.	Signs on 8th day. Bruit. Intense pulsation. Left pupil smaller than right. Thrill.	At operation: Varicose aneur. of common carotid art. & int. jug. v. Sac between art. & vein.	Double lig. art. & lateral lig. & resection of vein. 7 years until treatment.	Cure.	
38	Makins, G. H.: J. Roy. Army Med. Corps, Lond., 1905, iv, 741. (Monod & Vanverts.) Obs. 1.	Bullet. Male, 45. Left.	.....	Arterio-venous aneur. of common carotid artery & internal jugular vein.	Distal lig. art.	Cure.	
39	*Ibid.*, Obs. 2.	Bullet.	.....	Arterio-venous aneur. of common carotid artery & internal jugular vein.	Distal lig. artery.	Recidive.	
40	v. Oppel, W. A.: Arch. f. Klin. Chir., 1908, lxxxvi, 31. (Monod & Vanverts.)	Bullet. Male, 29.	.....	Arterio-venous aneur. of common carotid artery & internal jugular vein.	Partial extirpation.	Cure.	
41	Herzen, P.: Deutsche Zeitsch. f. Chir., 1910, civ, 241. (Monod & Vanverts.)	Bullet. Male. Right.	.....	At operation: Varicose aneur. of com. car. art. & int. jug. vein.	Extirpation.	Cure.	
42	Routier, A.: Bull. et mém. Soc. de chir., 1915, xli, 1395.	Missile. Male. Right.	Intense thrill with no ecchymosis. Region clammy.	Arterio-venous aneur. of common carotid artery & internal jugular vein.	Thrill disappeared when head was turned to side of wound.	Cure from posture.	
43	Duval, P.: Bull. Soc. de chir., 1915, xli, 1393.	Shell. Male, 39. Left.	Radiograph showed metallic fragment. Distinct thrill.	At operation: Aneurysmal varix of common carotid art. & int. jug. vein.	Double lig. & resection of vein. Distal lig. com. carotid artery.	Unknown.	
44	*Ibid.*, p. 460.	Trauma.	Laryngeal & pupil disturbances.	At operation: "Aneurysmal varix by dilation" of com. car. art. & int. jug. v.	Extirpation.	Cure.	
45	Guibal (de Béziers): Bull. et mém. Soc. de chir., 1915, xli, 1072.	Bullet. Male, 25. Left.	Thrill over slight scar. Swelling. Cont. bruit. Suffered no discomfort. No pulsa. or venous dilation.	At operation: Varicose aneur. of common carotid art. & int. jug. vein.	Distal lig. of art. & vein. Prox. lig. innom. & subcl. vein & carotid artery.	Cure.	Marked dil. int. jug. vein.
46	Parsons, Maj.: Brit. J. S., 1915-16, iii, 402. (Case 4, Makins' table.)	Bullet. Male. Left.	Typical signs of arterio-venous aneurysm.	Autopsy: Aneurysmal varix of com. car. art. & int. jugular vein.	No treatment.	Death.	Death from concurrent injuries to head.

II. ARTERIO-VENOUS ANEURYSMS OF THE COMMON CAR OTID ARTERY AND INTERNAL JUGULAR VEIN.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
47	Bond, Lieut.-Col., & Michael, Capt.: Brit. J. S., 1915-16, iii, 307.	Bullet. Male. Left.	Signs after 3 weeks. Expansile pulsation. Swelling. Marked thrill. Noises in head 3 days after inj. Slightly deaf in lt. ear. Giddiness on rising. Easily tired.	At operation: Intermed. Varicose encysted aneur. of common carotid art. & internal jugular vein.	Extirpation. 2 months until treat.	Cure.	
48	Telford, E. D.: Brit. J. S. 1915-16, iii, 322.	Shell. Male, 21. Left.	Swelling. Expansile puls. Harsh, buzzing bruit.	At operation: Varicose aneur. of common carotid art. & int. jugular vein.	Prox. lig. art. & suture of rent in sac. 1 month until treat.	Cure.	
49	Pozzi, S.: Bull. Soc. de chir., 1915, xli, 1162.	Bullet. Male, 33. Right.	Pulsating tumor size of fist on ant. surface of neck. Cont. thrill & bruit. Systolic expansion.	Arterio-venous aneur. of common carotid art. & int. jugular vein.	No treatment.	Spont. Cure.	
50	Bolt, R. F.: Lancet, 1916, ii, 1015.	Wound. Male, 25. Left.	2 days before, wound in cheek in front of lobe of ear.	At operation: Aneurysmal varix of common carotid art. & int. jug. vein.	Prox. lig. com. ext. & int. carotid arteries.	Cure.	

III. ARTERIO-VENOUS ANEURYSMS OF INTERNAL CAROTID ARTERY AND INTERNAL JUGULAR VEIN

51	Joret: Gaz. méd. de Par., 1840, 2me s., viii, 457 (from Stimson).	Bullet. Male, 35. Left.	Signs after 4 mos. Aphasia. Mental weakening. Epileptic attacks. Tumor size of pigeon's egg.	Arterio-venous aneur. of internal carotid & int. jugular vein. Ball found in lt. int. jugular vein.	No treatment.	Death after 30 months.	Foci of cerebral softening. Exophthalmus on left.
52	Giraldès: Bull. de la Soc. anat., 1854, xxix, 298 (from Stimson).	Shot. Male.	Diffuse swelling followed inj. Thrill & double murmur. 1 mo. later small puls. tumor.	Autopsy: Intermediate encysted varicose aneur. of int. car. art. & int. jug. v. Canal size crow's quill.	No treatment.	Death from anthrax.	
53	Keen, W. W.: Coll. & Clin. Rec., Phila., 1894, lxx, 380. (Monod & Vanverts.)	Shot. Male, 25. Left.	Immediate loss of sight in rt. eye. Paralysis of rt. arm. Gradual signs of art.-ven. aneur. Bruit.	Arterio-venous aneur. of int. car. art. & int. jug. v.	Lig. ext. car. art. at orig. lig. com. car. art. & int. jug. vein. 3 years until treatment.	Cure.	
54	Janssen, J. L.: Kiel, 1903, Schmidt & Klaunig, 21 p., 8°. (Bramann.)	Knife. Male, 21.	Pulsation. Thrill. Murmur. Signs after 4 days.	Arterio-venous aneur. of int. car. art. & int. jug. v.	Double lig. int. jug. vein, lig. com. car. & ext. car. A. & distal lig. int. car. art.	Cure.	
55	Cushing, H.: J. H. H. Surg. Nos. 17702, 20906, May 5, 1905.	Fracture. Male, 28. Right.	Roaring & buzzing. Right exophthalmus. Dil. of vsls. under lid. Bruit. Diplopia. Deafness in both ears. Venous pulsation.	Arterio-venous aneur. of int. car. art. & int. jug. v.	Ligation of int. car. art.	Improvement aft. 4 years.	
56	Bruce, A.: Rev. neurol. & psychiat., 1908, vi, 462.	Spont. Fem., 74. Left.	Loud cracking noise. Cont. noises in head. Left exophthalmus. Carotid arteries hard and cord-like.	Arterio-venous aneur. of int. car. art. & cavernous sinus.	No treatment.	Death.	Retinal veins both eyes congested. Followed influenza & pleurisy.
57	Bland-Sutton, Sir J.: Brit. J. S., 1915-16, iii, 490.	Bullet. Fem., 27. Left.	Signs after 6 hrs. Swelling. Loud buzzing in lt. ear. Thrill. Murmur like buzz. of fly imprisoned in paper.	At operation: Aneurysmal varix of int. car. art. & int. jug. vein.	Quadruple ligation. 7 weeks until treatment.	Weakness in rt. side.	Residual thrombosis of cavernous sinus.

III. ARTERIO-VENOUS ANEURYSMS OF INTERNAL CAROTID ARTERY AND INTERNAL JUGULAR VEIN.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
58	Quénu: Bull. Soc. de chir., Par., 1915, xli, 584.	Trauma. Male. Left.	Swelling. Pulsation. Thrill. Dil. right pupil. No dil. of superficial veins.	Arterio-venous aneur. of int. car. art. & int. jug. v.	Lig. of ext. int. & com. carotid arteries & int. jugular vein.	Cure.	
59	Lannois & Patel: La Caducée; 1915, Année, xv, 127.	Shell. Male, 29. Right.	Auditory disturbances. Rt. lingual & laryngeal paralysis. Thrill. Bruit.	Arterio-venous aneur. of int. car. art. & int. jug. v.	Obliteration of rt. lat. sinus. Lig. com. car. art. & int. jug. vein. 8 months until treatment.	Cure.	
60	Chartier: La Caducée, 1915, Année xv, 128.	Missile. Left.	Recurrent Brown-Séquard paralysis of left side, which improved.	Arterio-venous aneur. of int. car. art. & int. jug. v.	Lig. left common car. art. 1½ months until treat.	Cure.	
61	Heuer: J. H. H. Surg. Nos. 42083, 42514, Mar. 9, 1917.	Trauma. Male, 48. Right.	Dimness of vision. Cont. musical murmur. Deaf in rt. ear. Marked right exophthalmus.	Arterio-venous aneur. of int. car. art. & int. jug. v. Int. carotid tortuous.	Almost complete obliteration of int. car. art. by aluminum band.	Cure.	
	IV. ARTERIO-VENOUS ANEURSYMS OF EXTERNAL CAROTID ARTERY AND EXTERNAL JUGULAR VEIN						
62	Parkman: Amer. J. Med. Sci., 1853, xxv, 370.	Cut. Male, 35. Right.	Venous dilatation. Pulsation. Loud, purring thrill.	Aneurysmal varix of ext. car. art. & ext. jug. vein.	No treatment. Duration 24 years.	No change.	Apparent enlargement of com. & ext. carotid arteries.
63	Holston, J. G. T.: Western Lancet, 1856, xvii, 199.	Shot. Male, 50.	Pulsating tumor. Thrill. Throbbing. Hearing lost on affected side. Memory weakened. Paralysis left arm. Ext. jug. tortu. & dil.	Arterio-venous aneur. of ext. car. art. & ext. jug. v.	Hunterian lig. com. car. A. 15-20 yrs, until treat.	Death from lt. side paralysis.	Dil. of inf. laryngeal art.
64	D'Antona: Rev. de chir., 1888, viii, 510 (Abstract).	Trauma. Male.	After 10 years, arterio-venous aneur. of parotid & maxillary regions.	Arterio-venous aneur. of ext. car. art. & ext. jug. v.	Double lig. ext. car. art. & collateral branches. 10 yrs. until treatment.	Recidive.	
65	Postemski: Bull. d. r. Accad. med. di Roma, 1894, xx, 68. (Monod & Vanverts.)	Male, 30.	.....	At operation: Aneurysmal varix of ext. car. art. & ext. jugular vein.	Extirpation.	Cure.	Residual ptosis & deviation of point of tongue to left.
66	Roux: Rev. méd. de la Suisse romande, Genève, 1903, xxiii, 530.	Knife. Fem.	Redness of skin with fluctuation.	At operation: Intermediate encysted varicose aneur. of ext. car. art. & ext. jug. vein.	Double lig. external jugular vein.	Unknown.	
67	Berry, J.: Lancet, 1906, ii, 1714.	Fem., 39. Right.	No serious trouble for 20 yrs. when received blow. Swelling. Dyspnœa. Palpitation. Throbbing. Hoarse voice. Expan. pul. Systolic murmur. Thrill.	Arterio-venous aneur. of ext. car. art. (?) & large vein. Comm. not found.	Double lig. large vein & lig. facial, lingual, & sup. thyroid arteries. Resect. of tumor with 1½ in. ext. carotid artery.	Cure.	
68	Halsted, W. S.: Johns Hopkins Hosp. Surg. Histories. Surg. No. 28688.	Doubtful. 11 yrs. Right.	Earache, toothache, dizziness, pain in head & eye. Throbbing in head.	Art. ven, aneurysm of external carotid art. & venous sinus. Communication broad.	Proximal excision of vein. Proximal ligation of external carotid artery.	Improved.	5 months later no symptoms but pulsation, thrill and bruit present.

IV. ARTERIO-VENOUS ANEURYSMS OF EXTERNAL CAROTID ARTERY AND EXTERNAL JUGULAR VEIN.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
69	Turner, Maj. G. G.: Brit. J. S., 1915-16, iii, 282.	Bullet. Male, 29. Right.	Signs after 1 week. Swelling. Pulsation. Systolic bruit. No dil. superficial veins.	At operation: Varicose aneur. of ext.	Quad. lig. ext. car. art. & jugular v. & lig. facial & ling. art. Excision of s.	Cure.	
70	Reid, M. R.: Johns Hopkins Hosp. Surg. Hist. Surg. No. 45,-714.	Doubtful. 17 years. Right.	Second admission of patient. Chart No. 68. Swelling of face, numbness & throbbing.	Prox. lig. of ext. car. remnant & prox. lig. venous channels & partial excision of sac.	Arterio-ven. aneurysm of remnant of ext. car. art. and huge venous channels. Enormous prox. dilation.	Improved but fistulous comm. still present.	Striking pulsation right common carot. artery.

V. ARTERIO-VENOUS ANEURYSMS OF BRANCHES OF EXTERNAL CAROTID ARTERY AND EXTERNAL JUGULAR VEIN

71	Busche, G.: Lancet, Lond., 1827-28, ii, 413.	Congenit. Right.	Anastomosing aneurysm size of pigeon's egg. Ulceration.	Arterio-venous aneur. of temporal vessels.	*1st. op.* Extirpation. *2nd. op.* Prox. lig. ext. car. artery.	Hemorr. Cure.	
72	Green: Lond. Med. Gaz., 1828, ii, 188.	Cupping. Male, 25. Left.	Swelling. Pressure on art. stopped pulsation. Small, pulsating tumor.	At operation: Aneurysmal varix of temporal vsls.	Prox. lig. temp. art. & vein & lig. collateral.	Unknown.	
74	Fraser, W.: Brit.-Am. J., Montreal, 1845-6, i, 283.	Fall. Male, 20. Right.	Aneurysmal bruit. Peculiar thrill. Bone channeled.	At operation: Varicose aneur. of temporal vsls.	Treatment by harelip needles. 12 yrs. until treatment.	Cure.	Marked dil. rt. occipital & temp. arteries.
75	Reil: Halls, 1845. (Bramann.)	Spont. Male, 30.	Arteries & all branches dil. below. Strong thrill. Tumor size of half a hazelnut.	Arterio-venous aneur. of temporal vessels.	No treatment.	No change in 9 mos.	
73	De Massarellos, G.: Allg. Med. Zeitschr., 1844. (Bramann.)	Knife. Male. Right.	Signs in few days. Venous dil. Roaring noise. Headache.	Arterio-venous aneur. of temporal vessels. Distal obliteration of art. & prox. oblit. of vein.	Ligation of carotid artery (?). Incision of sac. Double lig. veins.	Failure. Cure.	
76	Moore, C. H.: Med. Chir. Trans., 1858, xli, 1.	Cut. Male, 60.	Pulsating. Swelling. Abscess & hemorrhage. Venous pulsa. Vibratory thrill.	Arterio-venous aneur. of temporal vessels.	Prox. lig. temp. art. & vein.	Cure.	Temp. art. tortuous.
77	Biefel: Deutsche Klinik, 1860. (Bramann.)	Contus. Male, 18. Left.	Tumor size of hen's egg. Slight pulsation. Temporal art. dilated.	At operation: Varicose aneur. of temporal vsls.	Extirpation.	Cure.	
78	Beach, H. A.: Boston Med. & Surg. J., 1868, lxxvii, 361.	Knife. Fem., 23.	Tumor size of pea. Heavy thrill. Cont. roar. Pulsation. Temp. art. dil. Dizziness.	At operation: Varicose aneur. of temporal vsls.	*1st. op.* Lig. com. car. art. fig. 8 lig. prox. & distally over harelip pins. *2nd. op.* Extirpation of tumor.	Hemorrhage. Cure.	
79	Czerny, V.: Arch. f. Kl. Chir., 1880, xxv, 943.	Knife. Male, 30.	Pulsating varices over right side of head.	Arterio-venous aneur. of temporal vessels.	Extirpation. 25 years until treatment.	Cure.	

V. ARTERIO-VENOUS ANEURYSMS OF BRANCHES OF EXTERNAL CAROTID ARTERY AND EXTERNAL JUGULAR VEIN.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
80	Power, Lieut.-Col. D.: Brit, J. S., 1915-16, iii, 297.	Bullet. Male. Left.	.....	At operation: Varicose aneur. of temporal vsls.	Extirpation.	Cure.	
81	Laugier: Gaz. des hôp., 1851. (Bramann.)	Congenit. Fem., 22. Left	Auricular & temporal veins dilated. Thrill. Pulsation. No murmur.	Arterio-venous aneur. of posterior auricular artery.	No treatment.	Death from childbirth.	Prox. & distal dil. of aur. art.
82	Bankart: Lancet, Lond., 1881, ii, 829.	Shot. Male, 20. Right.	Pulsating tumor. Thrill. Hum.	At operation: Varicose aneur. of facial artery.	Double lig. facial art. & lig. of collateral. 2½ years until treatment.	Cure.	Facial art. hyp. & tortuous.
83	Treves, Sir F.: Brit. Med. J., 1902, i, 1135.	Shot. Male. Right.	Dil. rt. ext. jug. v. Bruit. Vibratory thrill. Neuralgic pains. Giddiness. Sense of confusion.	At operation: Aneurysmal varix of internal maxillary vessels.	*1st. op.* Div. ext. car. art. above lig. of sup. thyroid & facial art. 5 months.	Improvement.	
					2nd. op. Lig. ext. car. art. below int. max. art. & lig. temp., ling. & occipital A.	Cure.	
84	Cushing, H.: N. Y. & Phil. Med. J., 1905, lxxxii, 1305.	Fall. Male, 31. Left.	Signs after 2 months. Pulsating swelling. Palpable thrill. Venous dil.	At operation: Aneurysmal varix of occipital vsls. Central thrombosis of art. Comm. 2 mm. in diam.	*1st. op.* Prox. lig. occ. art.	No change.	
					2nd. op. Prox. div. ext. car. art. & distal div. occ. & temp. arteries. Extirpation. 8 years until treatment.	Cure.	

VI. ARTERIO-VENOUS ANEURYSMS OF AXILLARY VESSELS

85	Rokitansky, K.: Beobachtung 46, 1852, (Taf. XXIII), p. 70.	Shot. Male, 62. Left.	Swelling of left arm. Flaccid tumor. Blowing, tugging rigor. Thrill. Sup. veins dilated.	Autopsy: Arterio-venous aneur. of axillary vsls. Suppuration of wound. False aneur. on ax. art.	Lig. subcl. art. above clav. 33 years until treatment.	Death after 14 sec. hemorr. & infect.	Prox. dil. of ax. A. Hyp. vein valves. Heart enlarged.
86	Legouest: Bull. Soc. de chir., 1862, ii, 94.	Bullet. Male. Left.	Cont. thrill. Swelling. Bruit. No venous dil.	Arterio-venous aneur. of axillary vessels.	No treatment.	....	
87	Bardeleben, K.: Diss., Berlin, 1871. (Bramann.)	Shot. Male, 20. Left.	Signs after 2½ weeks. Dim. per. pulsation. Venous dil. Murmur. Drop in temperature.	Arterio-venous aneur. of axillary vessels.	No treatment.	.....	Affected arm smaller than other.
88	Knaak, H.: Diss., Berlin, 1871. (Bramann.)	Shot. Male. Left.	Tumor. Venous dil. Pulsa. Thrill. Dim. in temperature. Sensory disturbances.	Aneurysmal varix of axillary vessels.	Compression.	Failure.	
89	Combalat: Gaz. des hôp. no. 126, 1879, p. 1003. (Bramann.)	Cut. Male, 55. Left.	Two tumors. Venous dilatation. Very little thrill.	Varicose aneurysm of axillary vessels.	No treatment.	No change.	

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
90	Bramann, F.: Verhandl. d. Deutsche Gesellsch. f. Chir., 1885, xiv, Th. 2, 273.	.....	Dim. in temp. in arm. Comm. large. Adhesions of nerves to tumor. Sens. dist. of hand.	At operation: Aneurysmal varix of axillary vessels.	Compression. Extirpation.	Failure. Cure.	
91	Tiling, G.: St. Petersb. Med. Woch., 1885, N. F. ii, 71. (Monod & Vanverts.)	Bullet. Male, 60.	.....	Arterio-venous aneur. of axillary vessels.	Extirpation.	Cure.	
92	Geschwind: Arch. de méd. et de phar. milit., 1890, xvi, 296. Obs. 1. (Monod & Vanverts.)	Knife. 25.	.....	Arterio-venous aneur. of axillary vessels.	Compression for 4½ months.	Cure.	
93	*Ibid.*, Obs. 2. (Monod & Vanverts.)	Knife. 35.	.....	Arterio-venous aneur. of axillary vessels.	Compression for 3 months.	Cure.	
94	Reclus, P.: La semaine méd., t. 10, 1890, p. 189.	Cut. Male, 44. Left.	Tumor size of pigeon's egg. Severe hemorrhage. Thrill.	Arterio-venous aneur. of axillary vessels.	Extirpation.	Cure.	Tumor adherent to median nerve.
95	Gongolphe, M.: Lyon méd., 1905, civ, 278. (Monod & Vanverts.)	.....	.....	Arterio-venous aneur. of axillary vessels.	Double lig. axillary art.	Cure.	
96	Mignon, A.: Bull. et mém. Soc. de chir., Par., 1905, xxxi, 535.	Knife. Male, 22. Right.	Signs after 2 months. Intense thrill. Cont. bruit. Venous dil. Dim. peripheral pulsation.	At operation: Aneurysmal varix of axillary vessels. Arterio-bi-venous aneurysm.	Extirpation. 4 months until treatment.	Cure.	Fistula comm. with 2 veins. Thrombosis of ax. vein.
97	Saigo, K.: Deutsche Zeitschr. f. Chir., 1906, lxxxv, 577. Obs. 6. (Monod & Vanverts.)	Bullet. 27.	.....	At operation: Arterial encysted varicose aneur. of axillary vsls.	Compression. Extirpation. 5 months until treatment.	Failure. Cure.	
98	Veau, V.: Duverger, Thèse de Par., 1906-7, no. 307. Obs. 4. (Monod & Vanverts.)	Knife. 15.	.....	At operation: Aneurysmal varix of axillary vessels.	Lateral suture of artery and vein. 2 months until treatment.	Cure.	
99	v. Oppel, W. A.: Arch. f. klin. Chir., 1908, lxxxvi, 31. Obs. 1.	Trauma. Male, 32. Left.	Signs immediately. Pulsating tumor size of walnut. Cont. thrill & bruit.	At operation: Varicose aneur. of axillary vsls.	*1st. op.* Prox. div. ax. art. & dist. div. ext. ax. vein. *2nd. op.* Prox. lig. ext. ax. V. & prox. lig. deep ax. vein. *3rd. op.* Extirpation.	B. P. sank to 0. B. P. rose to 40 mm., later sank to 0. B. P. rose to 30 mm.	3 operations in 9 hours.
100	Osler, Sir W.: Lancet, Lond., 1913, ii, 1248.	Cut. Male, 25. Left.	Pulsation. Cont. thrill & bruit. Swelling. Dim. per. pulsation.	Arterio-venous aneur. of axillary vessels. Specimen from aneur. not sufficient size to include fistula.	No treatment.	Death after 30 years.	Moderate dil. of heart. Aerial trans. of murmur. Fusiform prox. dil. ax. artery.

VI. ARTERIO-VENOUS ANEURYSMS OF AXILLARY VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
101	Durmin, R. B.: New Albany Med. Herald, Indiana, 1914, xxxi, 175.	Stab. Male, 25. Left.	Profuse bleeding. Swelling. Severe pain in arm. Superficial veins varicose. Thrill & bruit.	Arterio-venous aneur. of subscapular vessels.	Resection of subscap. art. extirpation of sac. & lat. suture of vein. 5 years until treatment.	Cure.	Residual anæsthesia.
102	Weicksel, J.: Münch. Med. Wchnschr., 1915, lxii, 241.	Bullet. Male, 32. Left.	Upper arm purple, swollen & useless. Cont. bruit. Distinct thrill.	Aneurysmal varix of axillary vessels.	Massage & electricity.	No change.	Temporary paralysis in upper arm.
103	Quénu, E.: Bull. et mém. Soc. de chir., 1915, xli, 895.	Bullet. Male. Left.	Violet discoloration of forearm. Pathognomonic thrill.	At operation: Varicose aneur. of axillary vsls.	Extirpation. 24 days until treatment.	Cure.	Partial paralysis of hand.
104	Mauclaire, P. & Monod, C.: Bull. et mém. Soc. de chir., 1915, xli, 2182.	Trauma. Male.	Characteristic signs of arterio-venous aneurysm.	At operation: Aneurysmal varix of axillary vsls. Fistula not found.	Extirpation.	Cure.	Injury to median nerve.
105	Duval, P.: Bull. Soc. de chir., Par., 1915, xli, 460.	Trauma. Male. Left.	Arterio-venous aneur. diagnosed.	At operation: Varicose aneur. "by dilation" of axillary vessels.	Double lig. subclav. & ax. arteries, proximally. 2 months until treatment.	Cure.	
106	From the Wharncliffe War Hospital, Sheffield: Brit. J. S., 1916-16, iii, 493.	Bullet. Male, 27. Left.	No thrill.	At operation: Aneurysmal varix of axillary vessels.	Prox. lig. subclav. art. & double lig. ax. vein. 10 days until treatment.		
107	2d. Northern Gen. Hosp., England: Brit. J. S., 1915-16, iii, 312.	Bullet. Male, 22. Left.	Diffuse swelling. Expan. pulsa. Marked thrill & murmur. ances.	At operation: Varicose aneur. of axillary vsls.	Extirpation. 19 days until treatment.	Cure.	
108	Sinclair, Maj.: Brit. J. S., 1915-16, iii, 406. (Case 23, Makins' tabl.)	Bullet. Male.	Murmur. Brachial monoplegia. Motor dist. of arm.	Arterio-venous aneur. of axillary vessels in 3rd portion.	Rest.		
109	Burrows, Capt.: *Ibid.* (Case 27, Makins' tab.)	Shell. Male.	Swelling. Murmur.	Arterio-venous aneur. of 2nd part axill. vsls.	Rest.	Improvement.	
110	Greaves, F. L. A.: Brit. Med. J., 1915, ii, 924. (Case 26, Makins' tab.)	Shell. Male.	Diffuse swelling. Expan. pulsa. Marked thrill & murmur.	Arterio-venous aneur. of axillary vessels.	No treatment.		
111	Bégouin & Moulinier: Jour. de méd. de Bordeaux, 1916, 87. Année, p. 76.	Shell. Male, 33.	Signs after 23 days. Continuous thrill & bruit. Venous dilation.	At operation: Aneurysmal varix of axill. vsls.	Extirpation.	Cure.	

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
112	Larrey: Clinique chirurgicale, 1811, xiv. (Bramann.)	Knife. Male.	Signs after 1 day. Murmur unchanged after 5 years. Pulsation. Unable to use arm.	Aneurysmal varix of subclavian vessels.	No treatment. Duration 5 years.	No change.	
113	Breschet, G.: Mém. de l'Acad. Roy. de Méd., 1833, iii, 101.	Stab. Male, 43. Right.	Signs after 5 days. Violent pulsa. & bruit. over scar. Venous dil. Slight compression caused vertigo.	Arterio-venous aneur. of subclavian vessels.	No treatment. Duration 20 years.		
114	Robert: Thèse de Par., 1842. (Bramann.)	Shot. Male, 50. Left.	Murmur. Dim. per. pulsation. Cold extremity.	Aneurysmal varix of subclavian vessels.	No treatment.	.....	Aerial transmission of murmur.
115	Wederstrandt, J. P. C.: N. Orl. M. News. & Gaz., 1854-5, i, 393-395. (Matas.)	Shot. Male. Right.	Violent primary hemorr. Injury to brachial plexus. Arm withered, paralyzed & cold. No sensation. Dim. peripheral pulsa.	Autopsy: Arterio-venous aneur. of subcl. vsls.	No treatment.	Death after 7 years.	
116	Fischer, G.: Mitth. aus d. Chir. Klinik. Göttingen, 1861. (Bramann.)	Knife. Male, 32. Left.	Tumor larger after lying. Shortness of breath. Feeling of cold.	Aneurysmal varix of subclavian vessels.	Compression.	Failure.	
117	Smith, R. W.: Proc. Path. Soc. of Dublin, 1861, n. s., i, pt. 3, p. 157.	Stab. Male. Left.	Pulsation. Thrill. Bruit. Dim. per. pulsa. Gangrene of hand.	Arterio-venous aneur. of subclavian vessels.	No treatment. Duration 7 months.	Recovery.	
118	Bérard: Bull. de Soc. de chir. de Par., 1865-6, ii, 367. (Matas.)	Knife. Male. Right.	Signs after a few days.	Arterio-venous aneur. of subclavian vessels.	No treatment.		
119	Letenneur: Bull. de Soc. de chir. de Par., 1865, 2 s., 1866, 367. (Matas.)	Bullet. Male, 15. Right.	Signs after 1 day. Swelling. Dysphagia.	Arterio-venous aneur. of 1st div. subcl. vessels.	Rest, diet, arnica compresses & ice.		
120	Lefort, L.: Dict. des Sc. Méd., Par., 1866. (Bramann.)	Shot. Male.	No pain. Caused no trouble for 7 years.	Autopsy: Varicose aneur. of subclav. art. & int. jug. vein.	No treatment.	Death.	
121	Will, J. C. O.: Glasgow Med. J., 1875, vii, 173. (Matas.)	Knife. Male. Left.	Sec. hemorr. in 4 days. Septic hemothorax. Pain in shoulder & elbow.	Autopsy: Arterio-venous aneur. of 3rd. div. subclavian vessels.	Operation attempted. 3 weeks until operation. Prelim. treat. medicinal.	Death at 1st. incision.	
122	Kirsch, B.: Arch. f. Kl. Chir., 1886, xxxiii, 13. (Matas.)	Bullet. Male, 27. Right.	Signs after 4 days. Tumor. Partial paralysis of arm.	Arterio-venous aneur. of 3rd. div. subcl. vessels.	Instrumental compression.	Failure.	
123	Arango, A. P.: Ann. de l'Acad. de Méd. de Medellin, 1892, xv, 55-57. (Matas.)	Stab. Male, 27.	Signs after 8 days. Partial paralysis of hand.	Arterio-venous aneur. of 3rd. div. subcl. vessels.	Compression.	Cure after 10 years.	

VII. ARTERIO-VENOUS ANEURYSMS OF SUBCLAVIAN VESSELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
124	v. Rotter, G.: Berl. Kl. Wchnschr., 1893, xxx, 279-284. (Matas.)	Knife. Male, 28. Left.	Syncope from hemorr. Signs following day. Dim. peripheral pulsation.	Arterio-venous aneur. of 3rd. subcl. vessels.	Prox. lig. subcl. artery.	Cure.	
125	Reboul: Thèse de Montpellier, 1894. (Matas.)	Fracture. Male, 30. Left.	Signs after 8 days. Enormous hematoma.	Arterio-venous aneur. of subcl. vessels.	No treatment.	Death after 5 days.	
126	Wedekind, G.: Deutsche Med. Wchnschr., 1895, xxi, 257-260. (Matas.)	Knife. Male, 32. Left.	Signs after 5 days. Numbness of arm. No inconvenience.	Arterio-venous aneur. of 3rd. div. subcl. vessels.	No treatment.		
127	Veiel: Med. Corres. des Wurt. Aerzt. Landsverein, Stuttgart, 1895, xli, 123. (Matas.)	Knife. Male, 23. Right.	Signs after 8 days.	At operation: Arterio-venous aneur. 3rd. div. subcl. vessels.	Double lig. art. & distal lig. vein.	.....	Residual motor, trophic & vascular disturbances.
128	Erdmann, J. F.: Ann. Surg., 1899, xxix, 618.	Bullet. Male, 20. Left.	Sensory motor dist. Murmur. Thrill. Enormous hematoma persisted 10 days.	At operation: Aneurysmal varix of 3rd. div. subcl. vessels.	Lig. of comm. & double lig. axillary & subcl. arteries. 3 months until treatment.	Cure.	
129	Matas, R.: Trans. Am. Surg. Assn., 1901, xix, 237.	Bullet. Male, 24. Right.	Large hematoma. Pulsation. Thrill. Cont. venous hum. Rasping, buzzing, reinforced, double murmur.	At operation: Aneurysmal varix of 3rd. div. subcl. vessels.	Double lig. art. & suture of orifice of vein.	Recovery.	Circulatory dist. Motor & sensory changes in hand.
130	Vallas: Rev. de Chir., Par., 1901, No. 7, pp. 23-30.	Fracture. Male, 25. Right.	Signs after 9 days. Hematoma.	Arterio-venous aneur. of 1st. & 2nd. div. of subclavian vessels.	Incision.	Death.	
131	Osler, W.: J. Am. Med. As., 1902, xxxviii, 1483. (Case 1.)	Bullet. Male, 29. Right.	Marked pulsa. Thrill & bruit. Wheezing, wiry, æolian murmur. Dim. per. pul.	Arterio-venous aneur. of subcl. vessels.	No treatment.		
132	Pluyette, E. & Bruneau, A.: Rev. de chir., 1905, xxxii, 46.	Bullet. Male, 33. Right.	Paralysis entire arm. Œdema hand & arm. Buzzing. Venous dil. Thrill. Dim. per. pul. Bruit.	.....	Bullet extracted.	Cure.	Absence radial pulse only trouble after 9 months.
133	Saigo, K.: Deutsche Zeitschr. f. Chir., 1906, lxxxv, 577. Obs. 3. (Monod & Vanverts.)	Bullet. Male, 24.	Paralysis of arm. Severe pain.	Arterio-venous aneur. subclavian vessels.	*1st. op.* Prox. lig. innom. v. *2nd. op.* Extirpation.	Recidive. Cure.	Adhesions of nerves to sac.
134	Greaves, F. L. A.: Brit. Med. J., 1915, ii, 924. (Case 19, Mak. table.)	Shrapnel. Male. Right.	Swelling. Ecchymosis. Thrill. Bruit. Sensory & motor dist. of arm.	Arterio-venous aneur. subclavian vessels.	Compresses, rest & elevation.	Improvement.	
135	Greaves, F. L. A.: Brit. Med. J., 1915, ii, 924. (Case 20, Mak. table.)	Bomb. Male. Right.	Swelling. Marked pulsa. & thrill. Cont. bruit. Dim. per. pul. Sensory & motor dist. hand & arm.	Arterio-venous aneur. of subclavian vessels.	Compresses, rest & elevation.	No change.	

VII. ARTERIO-VENOUS ANEURYSMS OF SUBCLAVIAN VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
136	Walther, C.: Bull. et mém. Soc. de chir., Par., 1915, xli, 1977.	Shell. Male. Left.	Anæsthesia & paralysis entire arm. Bruit. Thrill. Muscular atrophy.	Arterio-venous aneur. of subclavian vessels.	Rest.	No change.	Residual sensory & motor dist. arm.
137	Wright, G. A.: Lancet, Lond., 1915, ii, 1289.	Shrapnel. Male, 28. Right.	Pain in shoulder & axilla. Tumor. Pulsa. Thrill. Bruit. Dim. per. pulsation.	Arterio-venous aneur. of subclavian vessels.			
138	Berkley, C. & Bonney, V.: Brit. Med. J., 1916, i, 753.	Bullet. Male. Right.	Pulsating tumor size of walnut. Thrill. Paralysis of rt. arm.	Arterio-venous aneur. of varicose type 3rd. div. of subcl. vessels.	*1st. op.* Double lig. ax. & subcl. art. & lig. comm. *2nd. op.* Prox. lig. subcl. art. at innominate vein.	Hemorr. Recovery.	Nerve injury remained unchanged.

VIII. ARTERIO-VENOUS ANEURYSMS OF BRACHIAL VESSELS

139	Hunter, W.: Med. Obs. & Inquiries, 1762, ii, 390.	Lancet. Male.	Signs on 3rd. day. Tumor size nutmeg. Dim. per. pulsa. Venous dilation. Thrill. Murmur.	Arterio-venous aneur. of brach. vessels. Prox. dilation art. Bag-like dil. of vein.	No treatment. Duration 34 years.	No change.	All phenomena cease with compression of arterial trunk.
140	Hunter, W.: *Ibid.*	Venesect. Fem.	Hissing murmur. Tremulous, jarring thrill. Marked venous dilation.	Arterio-venous aneur. of brachial vessels. Prox. dil. art.	No treatment advised.	No change after 14 years.	
141	Cleghorn, G.: Med. Obs. & Inquiries, 1767, iii, 110. (Article dated 1765.)	Venesect. Male, 15. Right.	Small pulsating tumor. Thrill. Dim. per. pulsa. Tremulous motion & thrilling noise over tumor.	Aneurysmal varix of brachial vessels.	Change of occupation to lessen strain on arm.	Slowly grew worse.	Prox. dil. br. art.
142	White, W.: Med. Obs. & Inquiries, 1771, iv, 377.	Venesect. Male, 28. Right.	Basilic vein 3 times normal size. Pulsation. Thrill. Bruit. Dim. per. pulsation. Venous dil.	Varicose aneurysm of brachial vessels.	Duration 10 years.	.....	Prox. dil. br. art.
143	Armiger, T.: Med. Obs. & Inquir., 1772, iv, 382.	Venesect. Fem., 23. Right.	Signs in a few days. Swelling. Dil. basilic v. Thrill.	Arterio-venous aneur. of brachial vessels.	No treatment.	.....	Pressure on scar caused pulsation & thrill to cease.
144	Park: Med. Facts & Obs., 1793, iv, 111.	Venesect. Male, 20.	Hard, circumscribed, pulsating tumor size of walnut. Dil. basilic v. Inj. caused swelling, inflam., suppur., rupture of tumor & hemorrhage.	At operation: Varicose aneur. of brach. vessels.	Double lig. brach. art. & incision of sac.		
145	Scarpa: From the Italian trans. by Harles, 1808, S, 259. (Bramann.)	Venesect. Male. Right.	Numbness of limb.	Aneurysmal varix of brachial vessels.	Duration 14 years.		
146	Brambilla, A.: Acta Academiae, Caesario, Joseph, I, 1. (Bramann.)	Venesect. Fem., 30. Left.	Signs on 4th day.	Aneurysmal varix of brachial vessels.	Compression.	Cure in 6 months.	

VIII. ARTERIO-VENOUS ANEURYSMS OF BRACHIAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
147	Adelmann: Tractat. Anat. Chir. de Aneur. spurio varicoso, Herbipol, 1821. (Bramann.)	Shot. Male.	.....	Autopsy: Aneurysmal varix of brachial vsls.	.....	Death.	Prox. dil. br. art.
148	Breschet, G.: Mém. de l'Acad. Roy de Méd., 1833, iii, 101, Obs. 1.	Venesect. Male, 32.	Tumor. Venous dilation. Cont. thrill & bruit.	At operation: Varicose aneur. of brachial vsls.	*1st. op.* Prox. lig. art. (Anel.) *2nd. op.* Double lig. art. & incision of sac.	Return of symptoms. Cure.	
149	Breschet, G.: *Ibid.*, Obs. 2.	Venesect. Male, 22. Left.	Profuse hemorr. Arm red & swollen. Pulsating tumor. Cont. thrill & bruit.	At operation: Aneurysmal varix of brach. vessels.	*1st. op.* Prox. lig. art. (Anel.) *2nd. op.* Double lig. art.	Symptoms returned. Cure.	
150	Breschet, G.: *Ibid.*, Obs. 3.	Trauma. Male, 22.	Profuse hemorr. Signs after 6 weeks. Pulsa. & bruit. Large tumor. Venous dilation.	Arterio-venous aneur. brachial vessels.	Prox. lig. art. (Anel.)	Recidive.	Distal dil. art.
151	Smith, N. R.: North Am. Arch. M. & S. Sc., Baltimore, 1834-5, i, 241.	Venesect. Male, 26.	Distal & prox. dil. of median cephalic vein.	Arterio-venous aneur. of brachial art. & median cephalic vein.	Prox. lig. brachial artery.	Improvement.	
152	Schuh: Wien, 1840. (Bramann.)	Venesect. Fem.	Venous dilation. Thrill. Pulsation. Apparent thickening of art. prox.	At operation: Varicose aneur. of brachial art. & median vein.	Prox. lig. brachial artery.	Death from pyæmia.	
153	Syme, J.: Lond. & Edinburg Monthly J. Med. Sci., 1841, i, 7.	Venesect. Fem., 23.	.....	At operation: Varicose aneur. of brachial vessels.	Incision & partial extirpation of sac. 3 months until treatment.	Cure.	
154	Norris, G. W.: Am. J. Med. Sci., 1843, n. s., v, 27.	Venesect. Male, 42.	Aneur. at bend of elbow.	At operation: Aneurysmal varix of brach. vessels.	*1st. op.* Double lig. br. art. *2nd. op.* Double lig. vein & lig. collateral art. 3 months until treatment.	Hemorr. Cure.	
155	Dyer, S. S.: Prov. Med. & Surg. J., 1848, xii, 176.	Venesect. Male, 56.	Signs after 3 days. Pulsation. Swelling. Bruit.	At operation: Varicose aneur. of brach. vessels.	Prox. lig. brachial artery.	Cure.	
156	Roux: Rev. méd.-chir. de Par., 1850, vii, 338. (Obs. 1.)	Venesect. Male, 25.	Venous dil. Continuous thrill. Bruit. Loss of power in arm.	Arterio-venous aneur. of brachial vessels.	Double lig. brachial art. & distal lig. vein. 6 years until treatment.	Cure.	Prox. dil. & thinning of brachial artery.
157	Roux: *Ibid.*, Obs. 2.	Venesect. Fem., 30. Left.	Tumor size of small nut. Venous dil. Pulsation. Thrill over veins.	Autopsy: Varicose aneur. of brachial vessels.	*1st. op.* Prox. lig. br. art. *2nd. op.* Double lig. art. *3rd. op.* Amputation arm. 18 months until treatment.	Recidive. Hemorr. Death.	Dilation of br. art.

VIII. ARTERIO-VENOUS ANEURYSMS OF BRACHIAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
158	Roux: *Ibid.*, Obs. 3.	Venesect. Male. Left.	Signs after 4 years.	Arterio-venous aneur. of brachial vessels.	Compression for 3 years. *1st. op.* Double lig. br. A. *2nd. op.* Amput. above elbow. *3rd op.* Lig. br. art. below axilla. 7 years until operation.	Failure. Gangrene. Hemorr. Living 10 yrs. after.	
159	Bossé: Gaz. méd. de Par., 1850, no. 33. (Bramann.)	Venesect. Male, 40. Left.	Tumor size of hazelnut.	Varicose aneur. of br. vessels.	Galvano-puncture.	Cure.	
160	Letenneur: Bull. Soc. de chir., 1852, ii, 99.	Venesect. Male, 65.	Tumor size of apple. Characteristic thrill.	Arterio-venous aneur. of brachial vessels.	No treatment.	Tumor grew rapidly.	
161	Pravaz: L'union méd., 1852, No. 56. (Bramann.)	Venesect.	.....	Varicose aneur. of br. vessels.	Injection of Liq. Ferri sesqu. Amputation.	Gangrene aft. 11 da.	
162	Velpeau: Rev. méd.-chir., 1852, p. 231. (Bramann.)	Venesect.	.....	Varicose aneur. of br. vessels.	Injection Liq. Ferri. Lig. brachial artery.	Failure. Cure.	
163	Malgaigne: Rev. méd.-chir., 1852. (Bramann.)	Venesect. Male, 42.	Signs after 6 days. Thrill. Disability of arm.	At operation: Aneurysmal varix of br. vessels.	Double lig. brachial art.	Cure.	
164	Jobert (de Lamballe), A. J.: Bull. Acad. de méd., 1853-4, xix, 669. (Bramann.)	.....	.....	Aneurysmal varix of br. vessels.	2 injections of Liq. Fer. Treated immediately.	Cure.	
165	Heyfielder: Deutsche Klinik, 1859, S. 434. (Bramann.)	Venesect. Male.	.....	Arterio-venous aneur. of brachial vessels.	Compression for 72 hrs.	Failure.	
166	Richet: Bull. de la Soc. de chir., 1862, n. s., ii, 281.	Venesect. Male, 66.	Continuous bruit. Tumor size of pigeon's egg.	At operation: Varicose aneurysm of br. vessels.	Compression. *1st. op.* Double lig. art. & incision of sac. Distal lig. vsls. "en bloc." *2nd. op.* Prox. lig. ax. art. 4 months until treatment.	Failure. Hemorr. Death from inflammation.	
167	Broca: Bull. de la Soc. de chir., 1863, n. s., iv, 392.	Venesect. Male, 63. Right. ..	Rapid growth of tumor. Superficial veins dil. Rupture of sac & hemor. Bruit. Thrill. Pulsation. Dil. arterial system on rt. to innom. artery.	At operation: Varicose venous & intermed. encysted aneur. of br. vessels. Enormous dil. of art. prox.	Amputation. Middle of arm & inject. coag. fluid. Post-operative jaundice.	Death from gang. of stump.	Aneur. on prox. art. result of gen. dil.

VIII. ARTERIO-VENOUS ANEURYSMS OF BRACHIAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
168	Vanzetti: Giorn. Veneto, Luglio, 1863. (Bramann.)	Venesect. Fem., 28. Right.	Signs after 4 days.	Arterio-venous aneurysm of brachial art. & median basilic vein.	Direct & indirect comp. exerted on communication.	Cure aft. 6 hrs.	Varicose aneurysm changed into art. aneurysm.
169	Vanzetti: *Ibid.*	Venesect. Male, 54.	Tumor size of nut.	Varicose aneurysm of brachial vessels.	Compression for 6 hours.	Cure after 5½ mos.	
170	Vanzetti: *Ibid.*	Venesect. Male, 44.	.....	Arterio-venous aneurysm of brachial vessels.	Compression for 5 days.	Cure after 14 days.	
171	Pirogoff: Grundzüge d. Kriegschirurgie, Leipzig, 1864. (Bramann.)	Venesect. Male, 50.	Tumor size of egg.	At operation: Varicose aneurysm of brachial vessels.	*1st. op.* Prox. lig. br. art. *2nd. op.* Prox. lig. subcl. A. after 14 days.	Recidive & sec. hemorr. Death from sec. hem. & py.	
172	Ollier: Gaz. méd. de Lyon, 1866. (Bramann.)	Venesect.	.....	Varicose aneurysm of brachial vessels.	Compression exerted on communication.	Cure.	
173	Vanzetti: Gaz. des hôp., 1867. (Bramann.)	Venesect.	.....	Varicose aneurysm of brachial vessels.	Direct compression for 60 hrs. formed arterial aneurysm.	Trouble worse than before.	
174	Franzolini: Bull. et mém. Soc. de chir., 1867, viii, 356.	Venesect. Male, 33.	Signs after 2 yrs. Pain. Pulsation. Cont. thrill & bruit. Tumor size of hen's egg.	Varicose aneurysm of brachial vessels.	Compression.	Gradual recovery.	
175	Monmonier, J.: Virchow-Hirsch, 1868. (Bramann.)	Shot.	Signs immediately. Tumor size of egg.	Arterio-venous aneurysm of brachial artery & median basilic vein.	Obliteration of veins by figure-8 lig. over hare-lip pins.	Cure.	
176	Brenner: St. Petersb. Med. Ztschr., 1869. xvii, 42. (Bramann.)	Venesect. Fem.	Three tumors felt.	Varicose aneurysm of brachial vessels.	Galvano-puncture.	Improvement.	Called by author varicose aneurysm with phlebectasis.
177	Müller, M.: Arch. f. kl. Chir., 1873, xv, 725.	Shot. Male, 22.	Palpitation. Dim. per. pulsation.	Aneurysmal varix of brachial vessels.	Compression.		
178	Gripat, H.: Bull. et mém. Soc. de chir., 1882, viii, 803.	Wound. Male, 56. Left.	Tumor size of small nut. Arm œdematous, red & black. Expan. pulsation. Thrill. Serious symptoms after 42 yrs. Rupture of tumor.	Specimen: Varicose aneur. brachial vessels. Prox. oblit. of vein. Sac atheromatous. Distal oblit. of brachial vein.	Amputation. 45 years until operation.	Recovery.	Marked dil. of ax. & subcl. arteries. Gangrene of fingers after sac increased in size.
179	Kammerer, F.: N. Y. Med. J., 1891, liii, 173.	Shot. Male, 55.	.....	Autopsy: Varicose aneur. of brachial artery & cephalic vein.	No treatment known.	Death from pneumon.	
180	Menocal: (In Barreno Cron. Med.-Quir. de la Habana, 1891, xvii, 571. (Monod & Vanverts.)	Bullet.	Dilatation of superficial veins. Unknown operation performed 1 yr. after injury.	Arterio-venous aneurysm of brachial vessels.	Compression. Extirpation.	Failure. Cure.	

VIII. ARTERIO-VENOUS ANEURYSMS OF BRACHIAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
181	Marchant, G.: Bull. et mém. Soc. de chir., Par., 1898, xxiv, 747.	Stab. Male.	.....	At operation: Aneurysmal varix of brachial vsls. at juncture of ax. vsls.	Suture of brachial art., no remarks concerning vein.	Cure.	
182	Ker, J. E.: Surg. Exp. in South Africa, 1899-1900, p. 153. (Case 1.)	Male.	.....	Arterio-venous aneurysm at juncture of brachial & axillary vessels.	Prox. lig. brachial art.	Cure.	
183	Heinecke (In C. Francke): Thèse d'Erlangen, 1900. (Monod & Vanverts.)	Bullet. Male, 27.	.....	At operation: Aneurysmal varix of brachial vsls.	Extirpation.	Cure.	
184	Boddaert & Vercauteren: Bull. de la Soc. de méd. de Gand, 1903, lxx, 88.	Knife. Male, 26. Right.	Signs after 6 days. Pulsating tumor. Cont. bruit & thrill. Trophic, motor & sensory disturbances.	At operation: Aneurysmal varix of brachial art. & humeral vein in upper 3rd. region.	Lig. communication & double lig. vein.	Cure.	
185	Jeanne (In Ch. Brasseur): Thèse de Par., 1904-5, No. 348, Obs. 22. (Monod & Vanverts.)	Knife. 37.	.....	Arterio-venous aneurysm of brachial vessels.	Extirpation. 3 months until treatment.	Cure.	
186	Bornhaupt: Arch. f. Klin. Chir., 1905, lxxvii, 590. (Monod & Vanverts.)	Trauma. Male.	Adhesion of median nerve to sac.	At operation: Varicose aneurysm of brachial vessels.	Extirpation.	Cure.	
187	Cestan, E.: Toulouse méd., 1905, 2me s., vii, 176. (Monod & Vanverts.)	Bullet. 26.	.....	At operation: Aneurysmal varix of humeral artery & median basilic vein.	Extirpation.	Cure.	
188	v. Eiselsberg (in O. v. Frisch): Arch. f. Klin. Chir., 1906, lxxix, 515.	Bullet. Male, 28.	Signs after 3 years. Pulsation & thrill over scar. Tumor size of hen's egg. Venous dilation.	At operation: Aneurysmal varix of brachial vsls.	Extirpation.	Improvement.	
189	Stewart, J. C.: Ann. Surg., 1906, xliv, 920.	Shot. Male. Left.	Pulsating tumor. Superficial veins varicose. Harsh bruit & thrill.	At operation: Aneurysmal varix of brachial vsls.	Prox. lig. of brachial art. distal lig. radial & ulnar arteries. Excision of mass of veins.	Cure.	
190	Saigo, K.: Deutsche Zeitschr. f. Chir., 1906, lxxxv, 577. Obs. 12. (Monod & Vanverts.)	Bullet. 27.	Tumor size of hen's egg. Pain. Dim. peripheral puls.	At operation: Varicose intermediate encysted an. of inf. 3rd. br. vessels.	Compression. Extirpation. 41 days until treatment.	Failure. Cure.	

VIII. ARTERIO-VENOUS ANEURYSMS OF BRACHIAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
191	Saigo, K.: *Ibid.*, Obs. 13.	Bullet. 22.	Diminished peripheral pulsation.	At operation: Varicose intermediate encysted aneurysm of brach. vessels.	Compression. Extirpation. 3 months until treatment.	Failure. Cure.	
192	Saigo, K.: *Ibid.*, Obs. 14.	Bullet.	Tumor size of nut. Intense neuralgic pains.	At operation: Varicose venous encysted aneur. of brach. vessels.	Compression. Extirpation. 2 months until treatment.	Failure. Cure.	
193	Potherat, E.: Bull. et mém. de la Soc. de chir., 1907, xxxiii, 1036. (Monod & Vanverts.)	Knife. 19.	.....	Arterio-venous aneurysm of brach. vessels.	Extirpation.	Cure.	
194	Doyen, E.: 22d Cong. Franç. de Chir., 1909, 181. (Monod & Vanverts.)	Male, 11.	.....	At operation: Varicose aneurysm of brach. vessels.	Excision of sac with vein & lateral suture of artery.	Cure.	
195	Duval, P.: Bull. Soc. de chir., Par., 1915, xli, 1393.	Bullet. Male.	Œdema of lt. arm. Tumor size of hazelnut. Thrill.	At operation: Varicose intermediate encysted aneur. of brach. vessels.	Quadruple ligation.	Cure.	
196	Duval, P.: *Ibid.*	Bullet.	Thrill below pectoral tendon & down arm.	At operation: Varicose intermediate encysted anuer. brach. vessels.	Extirpation.	Cure.	
197	Delbet, P.: Bull. et mém. Soc. de chir., 1915, xli, 1397.	Bullet.	.....	At operation: Aneurysmal varix of brach. vsls.	*1st. op.* Lig. canal of communication. *2nd. op.* Extirpation.	Cure.	
198	Le Jemtel: Bull. et mém. Soc. de chir., 1915, xli, p. 2168.	Bullet. Male, 29.	Tumor size of pigeon's egg.	At operation: Varicose aneur. humeral art. & v.	Extirpation.	Cure.	
199	Tanton, J.: *Ibid.*, p. 2124.	Missile. Male.	Tumor size of hazelnut. Thrill. Bruit. Dim. per. pulsation.	At operation: Double arterial & venous encysted varicose aneur. of brach. vessels.	Extirpation. 3 months until treatment.	Cure.	
200	Weigel: Münch. Med. Wchnschr., 1915, lxii, 1119.	Bullet. Male.	Swelling. Thrill. Venous dilation.	At operation: Aneurysmal varix of brachial vsls.	Double ligation canal of communication.	Cure.	
201	Southam, Lieut.-Col.: Brit. J. S., 1915-16, iii, 319.	Bullet. Male. Left.	Swelling. Pulsation. Rasping bruit. Thrill. Dim. per. pulsation.	Arterio-venous aneurysm of brachial vessels.	Prox. lig. axillary artery & distal lig. brach. art.	Cure.	

IX. ARTERIO-VENOUS ANEURYSMS OF VESSELS OF FOREARM AND HAND

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
202	Schottin: Altenburg, 1822. (Bramann.)	Trauma. Fem., 65.	Signs 55 years. Rupture of varix during last 7 pregnancies.	Arterio-venous aneurysm of vessels about wrist. Bone plates in the walls of vein.			
203	Chisholm, S.: Lond. & Edinburg Monthly J. Med. Sci., 1844, iv, 312.	Venesect. Fem., 12.	Hemorrhage. No pulsation at wrist.	At operation: Aneurysmal varix of radial vessels.	Double ligation of radial artery.	Cure.	
204	Podracki: Woch. d. k. k. Gesellsch. d. Aerzte in Wien, 1862, S. 257. (Bramann.)	Venesect. Fem., 38	Tumor size of walnut.	At operation: Varicose aneur. of radial artery & median basilic vein.	Forced flexion. Compression. Prox. lig. radial artery.	Failure. Failure. Cure.	
208	Anderson, W.: Lancet, Lond., 1888, ii, 164.	Knife. Male, 39.	Pulsating swelling. Dil. superficial veins. Thrill. Murmur as of train running through tunnel. Dim. peripheral pulsation.	At operation: Varicose aneur. radial artery & deep median vein.	Compression. Lig. of brachial, rad. & ulnar arteries & median, med. basilic & med. ceph. veins.	Failure. Cure.	
209	Poncet, A. (In Villard, E.): Gaz. des hôp., 1893, lxvi, 965. (Monod & Vanverts.)	Trauma. 18. Left.	.....	Arterio-venous aneurysm of radial vessels.	Extirpation.	Cure.	
206	Thorndike: Bost. Med. & Surg. J., 1878, xcix, 475.	Fem., 19.	Swelling. Tumor size of goose's egg. Pulsation. Murmur.	Arterio-venous aneurysm radial vessels.	*1st. op.* Extirpation. *2nd. op.* Lig. brachial artery & lig. coll. artery.	Erysip. & sec. hem. Death from sepsis.	
207	Chalot: Bull. et mém. Soc. de chir., Paris, 1878, 2me s., t. iv, p. 84.	Venesect. Male.	Arterio-venous aneurysm diagnosed.	Aneurysmal varix of radial artery & median basilic vein.	No treatment.	Death from erysip.	
210	Abbe: Ann. of Surg., 1894, xix, 685.	Male.	.....	Aneurysmal varix of radial vessels.	Ligation radial artery. Styptic threads run through tumor & left 2 weeks.	Cord-like masses produced.	
205	Warren, J. M.: Warren's Surg. Observations, Boston, 1867, 461.	Contus. Fem., 19.	Thrill. Machinery bruit. Varicose veins. Dilatation of arteries.	Varicose aneurysm of palm of hand & arm.	Amputation.	Recovery.	Arteries in the palm like large sinuses.
211	Bazy: Bull. et mém. Soc. de chir., 1900, xxvi, 214. (Monod & Vanverts.)	Knife. 21. Right.	.....	At operation: Aneurysmal varix of interosseous vessels of forearm.	Extirpation.	Cure.	

IX. ARTERIO-VENOUS ANEURYSMS OF VESSELS OF FOREARM AND HAND.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
212	Rankin, Capt.: Brit. J. S., 1915-16, iii, 408. (Case 37, Makins' Table.)	Shell. Male. Right.	.....	Arterio-venous aneur. of radial vessels.	Extirpation.	Cure.	
213	Goodhart: Brit. Med. J., Lond., 1889, i, 1056.	Fem., 49.	Tender abdomen. Diarrhea. Bruit like venous hum. Profuse bleeding from bowel & stomach.	Autopsy: Aneurysmal varix of splenic artery & vein.	No treatment.	Death.	Thrombosis of gastric & mesenteric veins.

X. ARTERIO-VENOUS ANEURYSMS OF ABDOMINAL AORTA AND INFERIOR VENA CAVA

214	Syme, J.: Edin. Med. J., 1831, xxxvi, 104.	Spont. Male, 22.	Pain. Throbbing in epigastrium & whizzing noise. Large pulsating tumor. Œdema of lower extremities & generative organs.	Autopsy: Varicose aneur. of abdominal aorta & inferior vena cava.	Expectant treatment.	Death.	
215	Robinson, R. R.: Lond. Med. Gaz., 1834, xiv, 462.	Spont. Male, 42.	General anasarca. Varicose veins. Pulse quick. Urine bloody. Dyspnœa. Ulceration over tibia.	Autopsy: Varicose aneur. abdominal aorta & inferior vena cava. Heart hyp. & dilated.	Expectant treatment.	Death after 4 months.	
216	Simon: Lancet, 1875, Vol. VI. (Bramann.)	Male, 38.	Tumor size of hen's egg.	Aneurysmal varix of abdominal aorta & common iliac vein.	Attempted compression of the aorta.	Death from peritonitis.	Common iliac vein obliterated centrally.

XI. ARTERIO-VENOUS ANEURYSMS OF COMMON ILIAC VESSELS

217	Adams: Dublin J. Med. Sci., 1840-41, xviii, 166.	Spont. Male. Right.	Tumor. Purring sensation in lower part of abdomen.	Autopsy: Aneurysmal varix of common iliac vessels. Fusiform dilation of common iliac artery.	No treatment.	Death.	
218	Hewett, Sir P.: Lancet, Lond., 1867, i, 146.	Congen. Fem., 17. Right.	At birth rt. leg larger & 2 in. longer than left. Venous dil. Peculiar "beating" in leg. Swelling. Vibratory thrill. Systolic murmur. Bleeding scab on leg.	Arterio-venous aneurysm of common iliac vessels.	No direct treatment for fistula.	.....	Hydrocephalus as an infant.
219	Gosselin: Bull. Soc. de chir., 1854, iv, 138.	Stab. Male, 31.	Swelling of feet. Varicose veins. Ulceration. Bruit & thrill, over scar.	Arterio-venous aneurysm of common iliac vessels.	No treatment.		
220	Leflaive: Rev. méd.-chir. de Par., 1855. (Bramann.)	Knife. Male, 32. Right.	Signs after 14 days. Swelling. Enormous varices on left. Pulsa. & thrill in abdomen. Trophic changes. Large tumor. Pain. Elephantiasis. Ulceration.	Autopsy: Varicose aneur. of common iliac vessels. Cal. plaques in wall of vein.	No treatment.	Death.	Central obliteration of vein.
221	Chauveau: Jour. de la physiol., 1860, iii, 685.	Contus. Horse.	.....	Varicose aneurysm "by dilatation" of vasa vasorum of the varicose masseteric vein & artery.	.....	.....	Autopsy. Several branches of artery anastomosed with dilated vasa vasorum & these with varicose vein.

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
222	Barnes (Hodgson): Lond., 1815, 496.	Knife. Male, 17.	Pain in lower thigh.	Aneurysmal varix of femoral vessels, superior 3rd.	10 weeks until treatment. Compression.		
223	Breschet, G.: Mém. de l'Acad. roy. de méd., Par., 1833, iii, 101.	Knife. Male, 37. Right.	Continuous bruit & thrill. Tumor size of pea below Poupart's ligament.	Arterio-venous aneurysm of femoral vessels, superior 3rd.	No treatment.	Wound healed rapidly.	
224	Breschet, G.: *Ibid.*	Knife. Male, 22.	Varicose veins. Tumor size of nut. Thrill like "rustling of cord." Bruit.	Autopsy: Aneurysmal varix of fem. vsls. in Hunter's canal. Gangrene to knee.	7 months until treatment. Double arterial ligation.	.....	Distal dil. of fem. art. & branches.
225	Seger: Heidelberger Annal., 1835, Bd. I.	Knife. Male, 23. Left.	Dilation of artery above. 9 months later thick sac.	Aneurysmal varix of fem. vessels, superior 3rd.	Compression.	Failure.	
226	Perry, J. G.: Med. Chir. Trans., 1837, xx, 31.	Spont. Male, 47.	Old pop. arterial aneur. Pulsation. Dil. superficial vein. Thrill.	Autopsy: Varicose aneur. femoral vessels. Prox. dil. & thinning ext. iliac art.	Hunterian lig. femoral art.	Death from sec. hem.	Thinning of abdominal aorta. Calcium in aorta.
227	Venturoli: Nov. Com. Acad. Scient. Inst. Bonon. t. III. Bononiae, 1839. (Bramann.)	Blow. Male, 36. Left.	Tumor size of egg. Pulsation above Poupart's ligament.	Autopsy: Arterio-venous aneurysm of fem. vessels.	*1st. op.* Hunterian lig. ext. iliac artery. *2nd. op.* Dist. lig. fem. art. Incision. Tampon.	Sec. hem. aft. 42d day. Hemorr. Death from pyæmia.	
228	Horner, W. E.: Am. J. M. Sc., 1841, i, 74.	Bullet. Male, 30. Left.	Syncope following hemorr. Pulsa. Thrill. Purring bruit, like distant water-fall. Ulceration.	Autopsy: Arterio-venous aneur. of femoral vsls. Femoral artery dilated.	*1st. op.* Prox. lig. fem. art. at Poupart's ligament. *2nd. op.* Amput. of thigh at groin.	Gangr. Death.	
229	Baker, A.: Prov. Med. & Surg. J., 1850, xiv, 158.	Male, 41.	Bruit. Tumor size of walnut. Uiceration. Rushing thrill.	Autopsy: Varicose aneur. of origin of profunda art. & femoral vessels. Old arterial aneur. in Hunter's canal.	No treatment.	Death from pleurisy.	Femoral artery obliterated below. Communication.
230	Weber: Deutsche Klinik, 1851, iii, 313.	Grenade. Male. Left.	Distinct thrill. Bruit. Swelling of limb.	Autopsy: Aneurysmal varix of fem. vessels below origin of profunda artery.	No treatment.	Death.	Small piece of iron found at communication. Dil. of profunda & branches.
231	Hugier: Bull. Soc. de chir., Paris, 1852, ii, 100.	Stab. Male, 33. Left.	Claudication. Dilation superficial veins. Ulceration. Pulsa. Swelling. Bruit. Thrill.	Arterio-venous aneurysm of middle 3rd femoral vessels.	Galvano-puncture.	Failure.	Compression of fem. art. caused syncope. Signs after 6 years.
232	Monneret: Bull. Soc. de chir., 1852, ii, 68.	Shot. Male, 20.	Pulsation. Dilation fem. art. Continuous thrill & bruit.	Arterio-venous aneurysm of superior 3rd femoral vessels.	No treatment.		
233	Cooper, B.: Guy's Hosp. Rep., 1853, viii, 195.	Knife. Male, 15.	Signs after 5 days. Thrill. Bruit. Swelling of thigh.	Autopsy: Aneurysmal varix of femoral vessels of middle 3rd.	10 days until treatment. Double arterial ligation.	Death from hem. & infect.	

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
234	Giraldès: Bull. Soc. chir., 1854, iv, 22.	.....	Continuous thrill & bruit. Affected limb 3 cm. longer than other.	Arterio-venous aneurysm of superior 3rd femoral vessels.	No treatment.	.....	Lenth of affected limb increased.
235	Colles, A.: Dublin Quart. J. Med. Sci., 1855, xx, 341.	Fall. Male, 47. Left.	Pulsating tumor size of pigeon's egg. Varicose veins. Ulceration.	Arterio-venous aneurysm of lower 3rd femoral vsls.	No treatment.		
236	Pemberton, O.: Med.-Chir. Trans., 1861, xliv, 189.	Comp. Male, 50. Right.	Pulsating tumor. Dil. of ext. iliac & fem. arteries. Thrill. Bruit like steam forge-hammer. Int. saphenous vein enlarged. Skin discolored. Swelling of leg.	Autopsy: Varicose aneur. of superior 3rd. fem. vsls. & profunda art. & int. saphenous vein. Old arterial aneur. of post. tibial vsls.	No treatment.	Death.	Prox. dil. of arteries to com. il. Fistula formed by comp. Mitral & aortic disease.
237	Cordonnier, T.: Thèse, Par., 1864, No. 57, Obs. I.	Arrow. Male, 32. Left.	Ulceration. Varicose veins. Pulsation. Continuous thrill & bruit.	Arterio-venous aneurysm of superior 3rd fem. vsls.	No treatment.	Unknown.	Injury inflicted in childhood. Left leg 3 cm. longer than right.
238	*Ibid.*, Obs. II.	Knife. Male, 50. Right.	Continuous thrill & bruit. Ulceration. Skin brownish. Femoral art. tortuous.	Autopsy: Aneurysmal varix of superior 3rd. fem. vsls. Comm. size of crow's quill. Art. flexuous proximally.	Duration of aneur., 23 yrs. No treatment.	Death from erysipelas.	Femoral artery tortuous.
239	Cordonnier, T.: Thèse, Par., 1864, No. 57, Obs. III.	Shot. Male, 41. Left.	Signs after 5 days. Slow devel. of soft tumor. Pulsa. Thrill. Pain & numbness. Varicose veins. Swelling in left leg.	Arterio-venous aneurysm of superior 3rd. femoral vessels.	No treatment.	Unknown.	Prox. dil. fem. art. Comp. of tumor caused severe pain in heart. Coughing increased size of tumor.
240	Gayet: Gaz. hebd., 1864. (Bramann.)	Knife. Male, 19.	Murmur. Diminished peripheral pulsation.	Autopsy: Arterio-venous aneur. of superior 3rd. femoral vessels. 2 wounds in artery communicate with vein.	6 days until treatment. Compression not well stood. *Op.* Hunterian lig. of ext. iliac artery.	Sec. hem. Death from sepsis.	
241	Beaumont, W. R.: Lond. Med. Times & Gaz., 1867, ii, 87.	Knife. Male, 45. Right.	Continuous bruit. Sudden pain & swelling after 10½ years. Pulsation & thrill. Swelling of entire limb.	Autopsy: Varicose aneur. of superior 3rd. fem. vsls. Comm. almost occluded by organized clot. Osseous plates on int. of sac.	Compression.	Failure. Death from Chlorof. bef. op.	Prox. dil. com. fem. & ext. il. arteries. Serious signs after 10½ years.
242	Brindejonc-Trèglode, Y. M.: Thèse Montpellier, 1869 (?).	Stab. Male, 46.	Signs after 14 days. Scars of ulcers. Pulsating tumor. Continuous thrill & bruit.	Arterio-venous aneurysm of superior 3rd. fe. vsls.	Duration of aneurysm, 19 yrs. Compression.	Failure.	Apparent prox. dil. of femoral artery.
243	Spence, J.: Am. J. Med. Sc., 1869, lviii, 562.	Stab. Male, 15.	Pulsating swelling. Peculiar thrill & buzzing bruit. Dil. of upper int. saphenous vein. Dim. per. pulsation.	Arterio-venous aneurysm of superior 3rd. fem. vsls.	Compression. Double arterial ligation.	Failure. Cure.	Residual swelling of thigh.
244	Schinzinger: Das Res.-Lazar. Schetzingen, 1870-71. (Bramann.)	Shot. Male. Right.	Signs after 4 days. Thrill. Tumor. Œdema. Feeling of cold.	Arterio-venous aneurysm of superior 3rd. fem. vsls.	Compression & forced flexion.	Failure.	

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
245	Socin: Kriegs-Chir. Erfahrungen, Leipz., 1872. (Bramann.)	Shot. Male. Left.	Signs after 8 days. Thrill. Murmur, pulsation & tumor.	Autopsy: Varicose aneurysm of middle 3rd. fem. vsls. Complete section of art. 1st. distal valves injured.	18 days until treatment. *1st. op.* Prox. lig. fem. art. *2nd. op.* Amputation.	Hem. & Gangr. Death from sepsis.	
246	Fischer, G.: Deut. Ztschr. f. Chir., 1872, i, 153.	Bullet.	Signs after 9 days. Thrill. Pulsation.	Autopsy: Varicose aneurysm of inferior 3rd. fem. vsls. Femoral vein thrombosed.	Compression. Incision & double arterial ligation.	Failure. Death from gangr.	
247	Hamilton, T.: Lancet, Lond., 1874, ii, 543.	Knife. Male, 24. Right.	Diffuse swelling. Characteristic bruit. Thrill. Pulsating tumor.	Aneurysmal varix of sup. 3rd. femoral vessels.	Double arterial ligation.	Improvement.	
248	Hulke, J. W.: Med. Times & Gaz., 1875, ii, 251.	Shot. Male, 44. Right.	Severe pain in thigh & unusual throbbing. Cont. & rhythmical murmur like roaring of large bellows.	Aneurysmal varix of sup. 3rd. femoral vsls.	Compression twice. Given an elastic stocking.	Failure. Benefit.	Prox. dil. fem. art. Signs in two days. Superficial veins dilated.
249	Czerny, V.: Virchow's Arch., 1875, lxii, 464.	Knife. Male, 20. Left.	Signs after 14 days. Pulsating tumor size of fist. Continuous bruit. Dim. per. pulsation.	Varicose aneurysm of sup. 3rd. femoral vessels.	3 months until treatment. *1st. op.* Anel's lig. fem. art. *2nd. op.* Distal lig. art. & extirpation.	Failure. Cure.	
250	Smith, T.: St. Barth. Hosp. Rep., 1876, xii, 157.	Knife. Male, 14.	Purring thrill & murmur.	Arterio-venous aneurysm of middle 3rd. fem. vsls.	Compression.	Failure.	
251	Berger: Bull. et mém. Soc. de chir., Paris, 1878, iv, 605.	Knife. Male. Right.	Signs after 1 day. Thrill & continuous bruit.	Arterio-venous aneurysm of superior 3rd. fem. vsls.	Compression.	Failure.	
252	Roberts, W. O.: Louisville Med. News, 1879, vii, 52.	Shot. Male.	Signs in 2 weeks. Pulsating tumor, increasing rapidly in size.	Arterio-venous aneurysm of sup. femoral vessels.	Prox. lig. *en masse* of artery & vein.	Cure.	
253	Billroth: Chirurg. Klinik. Wien, 1879, S. 588. (Bramann.)	Knife. Fem., 32. Right.	Pulsation. Thrill. Tumor. Ulceration. Sensory disturbances.	Aneurysmal varix of sup. 3rd. femoral vessels.	4 years until treatment. Compression.	Failure.	
254	O'Grady, E. S.: Med. Press & Circ., 1880, xxx, 71.	Knife. Male, 28. Left.	Pulsating tumor size of cocoanut. Varicose veins. Usual bruit & thrill.	Autopsy: Varicose aneur. of middle 3rd. fem. vsls. External iliac art. size of aorta.	*1st. op.* Prox. div. fem. art. Injection of coag. subst. *2nd. op.* Lig. of com. iliac & internal iliac.	Recidive. Death.	Aneurysm formed at stump of artery.
255	Carafi, J. M.: Bull. de la Soc. anat. de Par., 1881, lvi, 706.	Shot. Male, 32.	Expansile pulsation. Purring thrill. Rough systolic bruit.	Autopsy: Varicose aneur. of superior 3rd. fem. vsls. Sac 26 cm. x 6 cm.	11 days until treatment. Compression.	Death from sepsis.	
256	Hutchinson, J. C.: Med. Rec., 1881, xx, 159.	Knife. Male.	No inconvenience from aneurysm for 9 years.	Arterio-venous aneurysm of femoral vessels.	*1st. op.* Lig. ext. iliac art. 6 months. *2nd. op.* Lig. com. iliac art. through peritoneum.	Failure. Death from perit.	

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
257	Van Buren: Med. Rec., 1881, xx, 159.	Bullet.	Eczema of leg. Swelling and weakness of leg.	Arterio-venous aneurysm of femoral vessels.	Given laced stockings.	Benefit.	
258	Bloch, L.: Beitrag zur Kenntnis etc. Zürich, 1881.	Knife. Male, 22. Right.	Signs immediately. Tumor size of pigeon's egg. Dim. peripheral pulsation.	Aneurysmal varix of sup. 3d. femoral vessels.	Ligation of fem. art. & v.	Death from gangr.	
259	*Ibid.*	Knife. Male, 25. Right.	Thrill & murmur.	Arterio-venous aneurysm of sup. 3d. femoral vsls.	Ligation of fem. art. & v. Extirpation.	Cure.	
260	*Ibid.*	Knife. Male, 53. Left.	Swelling of leg.	Arterio-venous aneurysm of middle 3d. fem. vsls. Complete section & retraction of artery.	Prox. lig. artery & vein.	Death.	
261	*Ibid.*	Knife. Male, 27. Right.	.....	Aneurysmal varix of sup. 3d. femoral vessels.	Prox. lig. of fem. art. & the profunda art. & vein.	Cure.	
262	Banks, C. E.: Rep. U. S. Marine Hosp. Service, 1882, 150.	Bullet. Male, 29.	Pulsation. Swelling. Pain. Almost continuous bruit. Signs after several mos.	Autopsy: Aneurysmal varix of superior 3d. fem. vsls. Distal contraction of art.	Compression. Lig. external iliac artery.	Failure. Death from gangr.	Prox. dil. fem. art.
263	Gallerand: Arch. de méd. navale, 1882, xxxviii, 146.	Knife. Male, 57. Right.	Signs after a few months. Pulsa., thrill & double bruit. Sup. veins varicose. Pain along course of nerves. Temperature lower on affected side.	Autopsy: Double encysted varicose aneurysm of fem. vsls. Dil. int. saph. v. Sac walls cornified. Tumor adherent to femur. Arteries thinned & veins thickened.	32 years until treatment. Compression.	Death.	Hyp. & dil. of heart. Prox. dil. a little above fist. Duration 32 years.
264	Ebenau: Berl. klin. Wchnschr., 1883, xx, 19-21.	Shot. Male, 21. Right.	Signs after 1 week. Thrill. Dim. peripheral pulsation. Sphygmograph. tracing shows a broad summit & marked anacrotism.	At operation: Varicose aneur. of sup. 3rd. fem. vsls.	3½ months until treatment. Quadruple lig. fem. vsls.	Cure.	
265	v. Wahl, E.: St. Petersburger Med. Wchnschr., 1883, S. 53. Jahrg. 8.	Knife. Male, 23. Left.	Pulsating tumor size of hen's egg. Bleeding ulcers. Varicose veins. Swelling of leg. Loud whirring & continuous hum.	At operation: Varicose arterial encysted aneur. of middle 3rd. fem. vsls.	Extirpation. 12 years until treatment.	Cure.	Calcar. plates in sac walls.
266	Pick, T. P.: Lond. Med. Times & Gaz., 1883, ii, 677.	Bullet. Male, 28.	Signs after 6 weeks. Cont. vibratory thrill. Oblong swelling. Pulsation. Cont. rough, blowing murmur. Swelling of leg below knee. Tumor soft.	Aneurysmal varix of sup. 3rd. femoral vessels.	Elastic stocking.	Unknown.	
267	Schwartz, E.: Union méd., 1884, xxxvii, 973.	Knife. Male, 18. Right.	Signs after 3 weeks. Pulsating tumor size of orange. Rough thrill. Artery above tumor was beginning to dilate. Sup. veins dilated.	Arterio-venous aneurysm of inferior 3rd. fem. vsls.	Compression	Failure.	Pressure over scar caused agitation, cyanosis of face & dyspnea. Evident heart lesion.
268	Trélat: Bull. et mém. Soc. de chir., 1884, x, 326.	Knife. Male, 13.	Signs after 10 days. Throbbing tumor 6 x 4 cm. Temperature of leg dim. in lower part of thigh. Cont. bruit.	Arterio-venous aneurysm of sup. 3rd. fem. vsls.	Compression	Cure.	Aneur. was transformed into circumscribed arterial aneurysm.

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
269	Vallas: Soc. nat. méd. de Lyon, 1886, i, 421.	Knife. Male, 19. Right.	Peculiar thrill. Continuous reinforced bruit. Dim. peripheral pulsation.	Arterio-venous aneurysm of middle 3rd. fem. vsls.			
270	Godwin, C. H. Y.: Brit. Med. J., 1887, i, 1271.	Stake. Male, 29.	Thrill. Swelling. Harsh, continuous bruit.	Varicose aneurysm of inferior 3rd. fem. vsls.	Compression 14 hours a day.	Improvement.	
271	Davies-Colley, N.: Guy's Hosp. Rep., 1888, 3. s., xxx, 347.	Bullet. Male, 37.	Signs after 5 days. Pulsation. Thrill & bruit. Swelling of affected leg.	At operation: Aneurysmal varix of sup. 3rd. fem. vessels. Fem. art. resembled congested small intestine.	5 years until treatment. *1st. op.* Double art. lig. 5 weeks. *2nd. op.* Mass lig. fem. art. & vein proximally. 4 months. *3rd. op.* Distal lig. fem. A.	Recidive. Recidive. Recidive.	Prox. dil. fem. art. Saphenous vein varicose.
272	Decamps, H.: Bull. Soc. anat. de Par., 1888, lxiii, 603.	Knife. Male, 81.	After initial compression no signs until 14 years. Pulsa. tumor, size of small egg. Cont. thrill & bruit. Trophic disturbances of hair & nalls.	Autopsy: Varicose aneur. of inferior 3rd. fem. vsls. A. & V. connected by 2 collaterals, on each of which is a sac.	2 months after onset compression treatment for 3 months, for sec. hem. with no trouble for 14 years.	Death from emphysema & cardiac lesion.	Prox. dil. & thinning of fem. art.
273	Walsham, W. J.: Med.-Chir. Trans., 1888, lxxi, 205.	Puncture. Male, 19.	Signs the following day. Pulsating tumor size of orange. Bruit. Venous hum & thrill.	At operation: Aneurysmal varix of sup. 3rd. fem. vsls.	Compression. 5 days. Extirpation.	Failure. Cure.	
274	Beatson & Fotheringham: Glasgow Med. J., 1888, xxix, 429.	Knife. Male, 30. Right.	Signs after 4 days. Thrill & bruit. Swelling of foot & leg.	Aneurysmal varix of sup. 3rd. fem. vsls.	Compression & splints.	Failure.	
275	Simons, M.: Tr. S. Carolina Med. Assn., 1889-91, 40th annual session, 125.	Bullet. Male, 25. Left.	Signs after a few weeks. Pulsating tumor. Thrill & bruit. Swelling of leg.	At operation: Varicose aneurysm of sup. 3rd. fem. vessels. Sac on vein & on intermediate.	Extirpation. 11 months until treatment.	Cure.	
276	Branham, H. H.: The Internat. J. Surg., 1890, iii, 250.	Bullet. Male, 24. Left.	Signs after 3 days. Thrill & bruit. Swelling.	At operation: Aneurysmal varix of sup. 3rd. fem. vsls.	2 months until treatment. Double ligation of art.	Cure.	Comp. of com. fem. art. caused slowing of heart-beats from 80 to 35, with dizziness & dyspnœa.
277	Zeidler, H.: Berl. klin. Woch., 1890, xxvii, 888.	.....	.....	Arterio-venous aneur. of femoral vessels.	Incision.	Cure.	
278	Levy, E.: Arch. de méd. militaire, 1er semestre, 1892, p. 298.	Knife. Male, 23. Left.	Rhythmic pulsation. Tumor size of nut. Bruit.	Arterio-venous aneurysm of femoral vessels. Complete section of vein.	Compression 4 days, 19 days. Double lig. art. & distal lig. vein.	Failure. Recovery.	
279	Faguet, C. & Aunis: Bull. Soc. anat. et physiol. de Bordeaux, 1893, xiv, 43.	Knife. Male, 25. Right.	Signs after 1 week. Expansile movements. Cont. reinforced thrill & bruit.	At operation: Varicose aneur. of sup. 3rd. fem. vsls.	28 days until treatment. Compression, 2 months. Extirpation.	Failure. Cure.	Temperature of right leg 2° higher than the left.

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
280	Lannelongue, M. (In Au-nis): Thèse de Bordeaux, 1893-4, No. 67. Obs. 18.	42.	.....	At operation: Varicose intermediate encysted aneurysm of fem. vsls.	*1st. op.* Lig. of com. iliac artery. *2nd. op.* Incision.	Suppur. of sac. Death from sepsis.	
281	*Ibid.*, Obs. 19.	Cut. 40.	.....	At operation: Varicose aneur. of middle 3rd. femoral vessels.	Compression. 4 months. Exirpation.	Failure. Cure.	
282	Roberts, J. B.: Annals of Surg., 1895, xxii, 372.	Bullet. Male, 26. Right.	Limb 3 times size of other. Superficial veins varicose. Pulsa. Purring murmur.	Autopsy: Double arterio-venous encysted varicose aneur. Valves of veins much hypertrophied.	6 years until treatment. Lig. of ext. iliac artery.	Death from gangrene.	Prox. dil. art. enormous.
283	v. Manteuffel, Z.: Verhandl. d. Deutsch Gesell. f. Chir., 1895, i, 167.	Contusion. Male, 32.	Hard & bony tumor adherent to femur.	At operation: Varicose aneur. of middle 3rd. femoral vessels. Tumor con. with marrow cavity.	4 weeks until treatment. Suture of 2 art. & 1 venous openings. Extirpation.	Cure.	
284	Howell, J. T.: N. Y. Med. J., 1896, lxiv, 215.	Stab. Male, 36. Right.	Signs after 3 days. Pain. Swelling. Expansile tumor size of orange. Thrill & bruit.	At operation: Varicose aneur. of sup. 3rd. fem. vsls.	Extirpation.	Cure.	
285	Habs: Deutsch. Zeitschr. f. Chir., 1897, xlvii, 97.	Cut. 19.	.....	Arterio-venous aneur. of middle 3rd. fem. vsls.	4 months until treatment. Extirpation.	Cure.	
286	Murphy, J. B.: N. Y. Med. Rec., 1897, li, 73.	Bullet. Male, 29.	Loud bruit. Thrill. Pulsa. Diminished per. pulsation.	At operation: Varicose aneur. of sup. 3rd. fem. vsls. of arterial encysted type.	19 days until treatment. Lateral suture of vein & end to end suture of resected artery.	Cure.	Aerial transmission of murmur.
287	Korlowski: Centralbl. f. Chir., 1897, xxiv, 997.	Bullet. Male, 27. Left.	Swelling. Diminished peripheral pulsation.	Arterio-venous aneurysm of superior 3rd. femoral vessels.	Ligation of external iliac art. & vein.	Cure.	
288	Means, W. J.: Columbus M. J., 1898, xx, 360.	Exertion. Male, 23.	Tumor size of quart cup.	At operation: Varicose aneur. of middle 3rd. fem. vsls.	Extirpation.	Unknown.	
289	Collin: Bull. et mém. Soc. de chir., Paris, 1899, xxv, 283.	Bullet. Male, 29.	Signs after 17 days. Bruit.	At operation: Varicose aneur. of sup. 3rd. fem. vsls.	1 month until treatment. Extirpation.	Cure.	
290	Routier, A.: Bull. et mém. Soc. de chir., Paris, 1899, xxv, 468.	Shot. Male, 36. Right.	Signs after 15 days. Tumor size of ostrich's egg. Pulsation. Varicose veins. Bruit.	Arterio-venous aneurysm of femoral vessels.	5½ years until treatment. Incision & quad. ligation.	Cure.	
291	Potherat, E.: Bull. et mém. Soc. de chir., Paris, 1899, xxv, 751, 804, 841.	Shot. Male, 15.	Signs after 6 months. Pulsation. Ulceration. Swelling of leg. Dil. superficial veins. Thrill. Reinforced bruit.	At operation: Varicose aneur. of sup. 3rd. fem. vessels. Fem. art. thinned below.	7 years until treatment. Extirpation.	Cure.	Prox. dil. fem. art.

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
292	Thiel: Centralbl. f. Chir., 1899, xxvi, 1226.	Bullet. Male, 16. Right.	Secondary hemorrhage on 14th day. Distinct thrill & bruit.	At operation: Varicose aneur. of sup. 3rd. fem. vsls.	14 days until treatment. Extirpation.	Cure.	
293	Montaz: Bourges, Thèse de Bordeaux, No. 52, 1900, p. 125. Obs. XI.	Missile. Male, 16. Right.	Pulsation. Continuous thrill & bruit.	At operation: Aneurysmal varix of sup. 3rd. fem. vsls.	Several years until treat. Double lig. art. & lateral suture of vein.	Cure.	
294	Cox, R. N.: Lancet, Lond., 1900, ii, 1074.	Bullet. Male, 23. Right.	Thrill. Loud, buzzing bruit. Leg cold & practically useless. Dim. per. pulsation.	At operation: Aneurysmal varix of sup. 3rd. fem. vsls.	3 months until treatment. Double arterial ligation.	Cure.	
295	Demons: Bourges, Thèse de Bordeaux, No. 52, 1900, p. 145. Obs. xviii.	Bullet. Male, 21. Right.	Signs after 14 days. Superficial pulsation. Bruit.	At operation: Varicose aneur. sup. 3rd. fem. vsls. Sac between art. & vein. Thinning of art. & thickening of vein.	3½ months until treatment. Extirpation.	Cure.	
296	Faguet, C. & Cabanes: Bourges, Thèse de Bordeaux, No. 52, 1900, p. 128. Obs. XII.	Knife. Male, 21. Left.	Swelling. Ecchymosis. Pulsating tumor. Cont. thrill & bruit. Dil. superficial veins. Dim. per. pulsation.	At operation: Aneurysmal varix of middle 3rd. fem. vessels.	Extirpation. 1 month until treatment.	Cure.	Rather marked atrophy of leg.
297	Faguet, C.: Bourges, Thèse de Bordeaux, No. 52, 1900, p. 119. Obs. IX.	Knife. Male, 40. Right.	Signs after 1 year. Tumor. Vibratory thrill. Pulsa. Swelling. Venous dilation. Dim. per. pulsation.	At operation: Varicose aneur. femoral vessels. Sac walls calcar. & attached to femur.	Extirpation. 4 months until treatment.	Cure.	Temperature at site of tumor 2° higher & over right calf 1.8° lower than left.
298	*Idem:* Bourges, Thèse de Bordeaux, No. 52, 1900, p. 114. Obs. VII.	Shot. Male, 42. Right.	Pulsating tumor. Venous dil. Pain. Cont. thrill & bruit. Dim. per. pulsation. Circum. right thigh 80 cm. & of left thigh 35 cm.	Autopsy: Varicose aneur. sup. 3rd. fem. vessels. Sac between art. & vein.	Ligation of common iliac artery. 26 years until treatment.	Death from sepsis.	Temperature of rt. thigh 4° higher than of left.
299	Cerné: Bourges, Thèse de Bordeaux, No. 52, 1900, p. 137. Obs. xv.	Knife. Male, 30. Left.	Signs after 6 weeks. Tumor size of hen egg. Reinforced pulsation. Swelling. Thrill. Bruit. Venous dil. Dim. per. puls.	At operation: Varicose aneur. middle 3rd. fem. vessels.	Extirpation.	Cure.	Temperature of lt. hip 2° higher than of right.
300	Lewtas, J. T.: Lancet, Lond., 1900, ii, 1299.	Bullet. Male.	Signs after 2 weeks.	At operation: Varicose aneur. sup. 3rd. fem. vsls.	*1st. op.* Anel lig. fem. art. *2nd. op.* Amput. at femur condyles. 3½ months until treatment.	Gangrene. Recovery.	
301	Findlay, J. W.: Glasgow M. J., 1901, lv, 174.	Fracture. Male.	Signs after 5 days. Cont. vibratory thrill. Swelling of leg. Abscess.	Autopsy: Varicose aneur. of sup. 3rd. fem. vsls.	No treatment.	Death.	
302	Halsted, W. S.: J. H. H. Surg. No. 12721, Nov. 26, 1901.	Stab. Male, 19.	Signs after 3 weeks. Tumor rapidly increased in size. Pain when walking. Expansile puls. Bruit.	At operation: Arterial encysted varicose aneur. of middle 3rd. fem. vsls. Opening in fem. art. 1 cm. long.	Double lig. fem. art. partial excision of sac & laterial suture of vein. 3 months until treatment.	.....	Residual intermittent claudication.

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
303	Fowler, G.: Ryerson Med. Rec., 1901, lix, 449.	Wound. Male, 30.	.....	Arterio-venous aneur. of femoral vessels.	*1st. op.* Quadruple lig. 15 months. *2nd. op.* Extirpation. 22 months until 1st. op.	Recidive. Cure.	
304	Treves, Sir F.: Brit. M. J., 1902, i, 1135. Case I.	Bullet. Male.	Swelling of thigh & leg. Feeble puls. Harsh, buzzing bruit. Vibratory thrill. Dim. per. puls.	At operation: Aneurysmal varix of inferior 3rd. femoral vessels.	Double lig. fem. art. & distal lig. of vein. 9 days until treatment.	Cure.	
305	*Ibid.*, Case III.	Bullet. Male.	Signs a few days after. Swelling. Buzzing bruit. Vibratory thrill. Venous dilation.	At operation: Aneurysmal varix of sup. 3rd. fem. vessels.	Double lig. femoral art. 6 months until treatment.	Slight recidive.	
306	Guinard, A.: Bull. et mém. Soc. de chir., Par., 1902, xxviii, 1125.	Knife. Male, 30.	.....	Specimen: Arterial encysted varicose aneur. of middle 3rd. fem. vsls.	Extirpation. 2 yrs. & 3 mos. until treat.	Cure.	
307	v. Eiselsberg (In Sprengel): These d'Erlangen, 1902.	Puncture. Male, 24.	.....	Arterio-venous aneur. of middle 3rd. fem. vsls.	Compression & injection of gelatine. 9 months. Extirpation.	Failure. Cure.	
308	Graves, S. C.: Am. Med., 1903, v, 962.	Bomb. Male, 21.	Signs almost immediately. Thrill. Expansile impulse & bruit.	Autopsy: Aneurysmal varix of middle 3rd. fem. vsls. Two pieces of iron found in tumor.	*1st. op.* Lig. ext. iliac art. *2nd. op.* Amputation. 6 years until treatment.	Gangrene. Death from sepsis.	Prox. dil. & thinning of iliac artery.
309	Bickham, W. S.: Ann. Surg., 1904, xxxix, 767.	Bullet. Male, 23.	Signs after a few days. Small pulsating tumor. Vibratory thrill. Murmur.	At operation: Varicose aneur. of sup. 3rd. fem. vsls.	Compression. Extraperitoneal ligation of external iliac artery.	Failure. Cure.	
310	Breyer, S. F.: J. Roy. Army Med. Corps, 1904, ii, 558.	Bullet. Male.	Pulsating tumor. Swelling varix bruit.	Arterio-venous aneur. of sup. fem. vessels.	*1st. op.* Double lig. fem. A. *2nd. op.* Lig. com. fem. art.	Recidive. Cure.	
311	*Ibidem*,	Bullet. Male.	Tumor. Loud varix bruit.	Arterio-venous aneur. of inferior 3rd. fem. vsls.	Double lig. femoral art. 1 month until treatment.	Improvement, but recidive.	
312	Franz: Arch. f. klin. Chir., 1905, lxxv, 572.	Knife. Right.	Swelling of leg. Thrill. Venous dil. Indenture high on the summit.	At operation: Varicose aneur. of fem. vsls.	Extirpation. 18 months until treatment.	Cure.	Sphyg. tracing shows definite anacrotism. Temp. of inj. thigh 1.5° higher.
313	Latour, L.: Presse méd., 1905, 522.	Bullet. 22.	.....	Arterio-venous aneur. of femoral vessels.	Incomplete extirpation.	Cure.	
314	Burrell, H. L.: Med. & Surg. Rep. of Boston City Hosp., 15th series, 1905, p. 162.	Stab. Male, 40.	Palpable thrill over wound area.	Arterio-venous aneur. of femoral vessels.	Extirpation. 13 days until treatment.	Cure.	

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
315	Osler, Wm.: J. H. H. Bull., 1905, xvi, 119.	Bullet. Male, 29.	Tumor size of pineapple. Swelling. Vibra. thrill. Reinforced murmur. Ulceration. Leg blue to foot.	Autopsy: Varicose aneur. of inferior 3rd. fem. vsls. Sac formed of dense fibrous tissue.	No treatment.	Death.	Prox. dil. fem. art.
316	Bornhaupt, L.: Arch. f. Klin. Chir., 1905, xlvii, 590. Obs. 10.	Bullet. Male, 26.	Tumor size of fist.	At operation: Varicose intermediate encysted aneur. of middle 3rd. fem. vessels.	Extirpation. 32 days until treatment.	Cure.	
317	Bornhaupt, L.: Arch. f. Chir., 1905, xlvii, 590. Obs. 11.	Wound. Male.	Tumor size of fist.	At operation: Varicose encysted venous aneur. of inferior 3rd. fem. vsls.	Extirpation. 32 days until treatment.	Cure.	
318	v. Frisch, O.: Arch. f. Klin. Chir., 1906, lxxix, 515.	Cut. Male, 24. Right.	Signs after 5 months. Pulsation. Tumor. Bruit.	At operation: Aneurysmal varix of sup. 3rd. fem. vsls.	Compression & injections of gelatine. Extirpation. 10 months until treatment.	Failure. Cure.	
319	Garrè, C.: Deutsche Ztschr. f. Chir., 1906, lxxxii, 280.	Knife. Male, 26. Right.	Signs immediately. Thrill. Swelling. Ulceration. Bruit. Varicose veins. Venous puls.	At operation: Varicose aneur. of middle 3rd. fem. vsls.	Double lig. vein. & lat. suture of artery. 10 years until treatment. Extirpation of sac.	Cure.	
320	Saigo, K.: Deutsche Ztschr. f. Chir., 1906, lxxxv, 577. Obs. 22.	Bullet. 22.	Diminished peripheral pulsation.	At operation: Varicose arterial encysted aneur. femoral vessels.	Compression. Extirpation. 6 months until treatment.	Failure. Cure.	
321	*Ibid.*, Obs. 23.	Bullet. 26.	.....	At operation: Aneurysmal varix of sup. 3rd. fem. vsls.	Compression. 4 years. *1st. op.* Double lig. fem. art. *2nd. op.* Amputation of hip.	Failure. Gangrene. Recovery.	
322	*Ibid.*, Obs. 24.	Bullet. Male, 25.	Diminished peripheral pulsation.	At operation: Aneurysmal varix of middle 3rd. fem. vessels.	Compression. Extirpation. 5 months until treatment.	Failure. Cure.	
323	*Ibid.*, Obs. 26.	Bullet.	.....	At operation: Aneurysmal varix of sup. 3rd. fem. vsls.	Compression. Extirpation. 6 months until treatment.	Failure. Cure.	
324	*Ibid.*, Obs. 27.	Bullet.	Diminished peripheral pulsation.	At operation: Varicose venous encysted aneur. sup. 3rd. fem. vsls.	Compression. Extirpation. 6 months until treatment.	Failure. Cure.	
325	*Ibid.*, Obs. 28.	Bullet. Male, 32.	Atrophy and loss of power of leg.	At operation: Arterial encysted varicose aneur. of sup. 3rd. fem. vsls.	Double lig. fem. art. & incision of sac. 1 year until treatment.	Cure.	

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
326	Leme, B. P.: 13. Cong. internat. de méd. Lisbonne, 1906, sect. de Chir. lx, 407.	.....	.....	Arterio-venous aneur. of femoral vessels.	Extirpation.	Cure.	
327	Westergaard, V. M.: Hospitalstidende, 1907, 4th. series, xiv, 563.	Knife. Male, 19.	.....	Arterio-venous aneur. of femoral vessels.	Double lig. & extirpation of art. & lat. lig. vein. 3 years until treatment.	Cure.	
328	Gessner, H. B.: New Orleans M. & S. J., 1907-8, lx, 553.	Shot. Male, 22. Right.	Signs after 11 years. Pulsation. Thrill. Aneurysmal bruit.	At operation: Aneurysmal varix of middle 3rd. fem. vessels.	Suture through sac of 2 venous & 1 arterial communications. 12 years until treatment.	Unknown.	
329	Delanglade & Dugas: Marseille médicale, 1908, xlv, 512.	Shot. Male. Left.	Signs 2 days after. Thrill. Systolic expansion of swelling.	At operation: Varicose aneur. sup. 3rd. fem. vsls.	Extirpation. 1 month until treatment.	Cure.	
330	Pieri: Marseille méd., 1908, xlv, 515.	Knife.	Diminished peripheral pulsation.	Arterio-venous aneur. of femoral vessels.	Quadruple ligation. A few days until treat.	Death from gangrene.	
331	Auvray, M.: Rev. de chir., 1909, xl, 758.	Knife. Male, 15. Right.	Signs after 2 weeks. Thrill. Bruit. Tumor. Pulsation. Progressive numbness of leg.	At operation: Varicose aneur. sup. 3rd. fem. vsls.	Lat. sut. art., lat. lig. vein & extirpation of sac. 1 month until treatment.	Cure.	
332	Fabre: Echo méd. d. Cévennes, Nîmes, 1909, x, 251.	.....	.....	Arterio-venous aneur. of sup. 3rd. fem. vsls.	Extirpation.	Cure.	
333	Jullien: L'Echo méd. du Nord, 1911, xv, 104.	Shot. Male, 39.	Swelling & gangrene of leg.	At operation: Varicose aneur. sup. 3rd. fem. vsls.	Quadruple lig. fem. vsls. 3 months until treatment.	Death from heart syncope.	
334	Greiss, W. R.: The Lancet Clinic, Cincinnati, 1912, cvii, 658.	Bullet. Male, 37.	Swelling of leg. Pain. Pulsation. Thrill & bruit.	At operation: Varicose aneur. of sup. 3rd. fem. vessels.	Resection of art. & sac used to mend vein. 5 yrs. 7 mos. until treat.	Cure.	
335	Halsted, W. S.: J. H. H. Surg. No. 27331, Feb. 9, 1911.	Missile. Male, 55.	Pain. Systolic & diastolic thrill & bruit. Dil. superficial veins.	Aneurysmal varix of sup. 3rd. fem. vsls. Beginning calcification of fem. A.	Partial obliteration of fem. vein by aluminum band. 4 months until treatment.	No change.	
336	Heuer, G.: J. H. H. Surg. No. 32461, July 15, 1913.	Shot. Male, 47. Left.	Signs after 28 years. Throbbing of art. Swelling of leg. Thrill. Roaring bruit. Dim. per. pulsation.	At operation: Aneurysmal varix of sup. 3rd. fem. vsls. Art. above fistula size of index finger.	Lateral suture of art. & vein. 30 years until treatment.	Death from pneumonia 44th day after op.	Prox. dil. fem. art.
337	Eisenbrey, A. B.: J. Am. Med. Assn., 1913, lxi, 2155.	Bullet. Male, 61. Left.	Pulsating expansile tumor. Cont. reinforced murmur.	Autopsy: Varicose aneur. of sup. 3rd. fem. vsls. Hyp. & dil. of heart. Dil. ext. iliac art. Thin-walled sac on art. Thickening of vein extended into vena cava.	No treatment. Duration of aneur., 18 yrs.	Death.	Increased cardiac dulness. Mitral insufficiency. Auricular fibrillation.

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
338	Stewart, F. T.: Ann. Surg., 1913, lvii, 574.	Knife. Male, 7. Left.	Signs after 1 month. Soft, systolic murmur. Distinct enlargement of heart. Reinforced cont. bruit & thrill. Dil. venules.	At operation: Aneurysmal varix of middle 3rd. fem. vessels.	Lat. sut. fem. art. reinforced by flap of muscle & lat. sut. vein. 4 years until treatment.	Cure. Heart dim. in size. Murmur gone.	Injured leg 1 in. longer than right.
339	Toussaint, H.: Bull. et mém. Soc. de chir., Paris, 1915, xli, 2051.	Shell. Male.	.....	Arterio-venous aneur. of femoral vessels.	Extirpation.	Cure.	
340	Davis, G. G.: Trans. Phila. Acad. Surg., 1915, xvii, 212.	Knife. Male, 10.	.....	Arterio-venous aneur. of sup. 3rd. fem. vsls.	No treatment.	.....	Injured leg longer than other.
341	Soubeyran (de Montpellier): Bull. et mém. Soc. de Chir., Par., 1915, xli, 892.	Wound. Male.	Swelling of thigh & leg.	Arterio-venous aneur. of sup. 3rd. fem. vessels.	Incision & quad. lig. 14 days until treatment.	Death from gangrene.	
342	Quénu, E.: Bull. et mém. Soc. de chir., Par., 1915, xli, 895.	Bullet. Male, 40. Left.	Signs after 1½ months. Signs of phlebitis. Purring & pulsation. Bruit. Dim. per. pulsation.	Arterio-venous aneur. of middle 3rd. fem. vsls.	Quadruple ligation. 7 weeks until treatment.	Cure.	
343	Godwin, H. J.: Brit. Med. J., 1915, 11, 925.	Shot. Male. Right.	Pain. Swelling. Thrill. Harsh roaring bruit.	At operation: Varicose aneur. of middle 3rd. fem. vsls.	*1st. op.* Resection & anas. of vein. 5 months later. Lat. suture of artery. 18 days until treatment.	Cure.	Reinforced graft on art. of internal saphenous vein.
344	Greaves, F. L. A.: Brit. M. J., 1915, ii, 924.	Bullet. Male.	Pulsation. Thrill. Bruit. Swelling of leg.	Arterio-venous aneur. of sup. 3rd. fem. vsls.	Rest and elevation.	Improvement.	Aerial transmiss. of murmur.
345	Harrass: Münch. Med. Wchnschr., 1915, lxii, 240.	Bullet. Male, 23. Left.	Pulsating tumor larger than hazelnut. Thrill.	At operation: Varicose aneur. sup. 3rd. fem. vsls. Sac on artery.	Double lig. & sut. art. & excision of sac. 38 days until treatment.	Cure.	
346	Le Jemtel: Bull. et mém. Soc. de chir., 1915, xli, 2168.	Bullet. Male.	.....	Arterio-venous aneur. of sup. 3rd. fem. vsls.	Multiple lig. fem. vsls. 2 months until treatment.	Cure.	
347	Mauclaire, P.: Bull. et mém. Soc. de chir., 1915, xli, 2051.	Bullet. Male.	Tumor size of chestnut.	At operation: Venous encysted varicose aneur. of sup. 3rd. fem. vsls.	Extirpation. 7 weeks until treatment.	Cure.	
348	*Idem: Ibid.*, 1915, xli, 1305.	Bullet. Male.	Signs after 9 days.	At operation: Varicose venous encysted aneur. femoral vessels.	Extirpation.	Cure.	
349	From the Wharncliffe War Hosp., Sheffield: Brit. J. S., 1915-16, iii, 492.	Bullet. Male, 22.	Pulsating red swelling. Thrill. Murmur. Dim. per. Pulsation.	Autopsy: Aneurysmal varix of sup. 3rd. fem. vsls. "Profunda art. of large size."	Double lig. art. & distal lig. vein. 24 days until treatment.	Cure.	

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
350	Page, Capt. M.: Brit. J. S., 1915-16, iii, 410. Case 59.	Bullet. Male. Left.	Patch of gangrene on foot.	Arterio-venous aneur. of middle 3rd. fem. vsls.	Double lig. art. & distal lig. vein.	Cure.	
351	*Ibid.*, Case 60.	Bullet. Male. Left.	Gangrene of foot & lower third of leg. Large tumor.	Arterio-venous aneur. of middle 3rd. fem. vsls.	Double lig. fem. artery.	Death from gaseous cellulit.	
352	From 2d Northern Gen. Hosp., England: Brit. J. S., 1915-16, *iii*, 314.	Bullet. Male, 27. Left.	Cont. thrill. Loud, blowing bruit. Expansile pulsation. Pain. Numbness.	At operation: Varicose aneur. of mid. 3rd. fem. vsls.	Extirpation. 18 days until treatment.	Cure.	Common femoral art. slightly dil.
353	Eccles, Maj. W. M.: Brit. J. Surg., 1915-16, iii, 298.	Bullet. Male. Left.	Swelling. Pulsation. Cont. bruit. Discoloration of skin.	At operation: Aneurysmal varix of sup. 3rd. femoral vessels.	*1st. op.* Quad. lig. *2nd. op.* Amputation. 10 days until treatment.	Gangrene. Recovery.	
354	Angus, Lieut.-Col. H. B.: Brit. J. Surg., 1915-16, iii, 291.	Shrapnel. Male. Right.	Expansile swelling. Thrill. Loud, purring bruit.	At operation: Aneurysmal varix of middle 3rd. fem. vsls.	Double lig. fem. artery. 2 weeks until treatment.	Cure.	
355	Duval, P.: Bull. et mém. Soc. chir., Paris, 1915, xli, 460. Obs. 2.	Bullet. Male. Left.	Diagnosis of arterio-venous aneurysm.	Arterio-venous aneur. of sup. 3rd. fem. vsls.	Quad. lig. fem. vsls. 3 months until treatment.	Cure.	
356	*Ibid.*, Obs. 4.	Bullet. Male. Left.	.....	At operation: Aneurysmal varix of sup. 3rd. fem. vsls.	*1st. op.* Quad. lig. fem. A. & V. & lig. prof. A. & deep fem. vsls. *2nd. op.* Amput. at knee. 2½ mos. until treatment.	Gangrene. Recovery.	
357	*Idem:* Bull. et mém. de Soc. de chir., Paris, 1915, xli, 460.	Bullet. Male. Left.	.....	Arterio-venous aneur. of sup. 3rd. fem. vsls.	Quad. lig. & incision.	Death from hemorr.	
358	Broca, A.: Bull. et mém. Soc. de chir., 1915, xli, 1396.	Bullet. Male, 20.	Classic signs after 24 days.	At operation: Aneurysmal varix of sup. 3rd. femoral vessels.	Extirpation.	Cure.	
359	Walther, C.: Bull. et mém. Soc. de chir., Par., 1915, xli, 95.	Shot. Male, 21. Left.	Signs after 19 days. Pulsating tumor size of large nut. Thrill. Bruit.	Arterio-venous aneur. of inferior 3rd. fem. vsls. Vein "arterialized."	Quad. lig. fem. & poplit. vsls. & extirpation. 2 mos. until treatment.	Cure.	Prox. dil. fem. art.
360	Hodge, E. B. & Sweet, J. E.: Trans. Phila. Acad. Surg., 1915, xvii, 209.	Bullet. Male, 29.	Signs after 1 year. Tumor size of pea. Swelling. Pulsation. Loud to-and-fro murmur.	At operation: Aneurysmal varix of sup. 3rd. fem. vsls.	Suture of communication. 16 years until treat.	Cure.	Prox. dil. art. up. ext. iliac artery.
361	Southam, Lieut.-Col.: Brit. J. S., 1915-16, iii, 319.	Bullet. Male, 26.	Signs after 15 days. Tumor size of cherry. Thrill & whizzing sound. Dim. peripheral pulsation.	At operation: Varicose aneur. fem. vsls. in Hunter's canal.	Double lig. fem. art. 15 days until treatment.	Cure.	

XII. ARTERIO-VENOUS ANEURYSMS OF FEMORAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
362	Carline, Col.: Brit. J. S., 1916, iv, 189.	Bullet. Male, 36. Left.	Venous thrill.	At operation: Aneurysmal varix of sup. 3rd. fem. vsls.	*1st. op.* Prox. lig. fem. art. Compression ½-hr. each day for 2 mos., 6½ mos. aft. *2nd. op.* Distal lig. prof. artery. 6 weeks until treatment.	Recidive. Improved circul. Cure.	
363	Joyce, J. L.: Brit. J. S., 1916, iv, 181.	Bullet. Male, 26.	Signs after 11 days. Pulsation. Thrill. Bruit. Unsuccessful operation to extract bullet.	Autopsy: Aneurysmal varix of inferior 3rd. femoral vessels.	Double arterial lig. Later: Amput. at upper thigh.	Gangrene. Death from sepsis.	
364	4th. Northern Gen. Hosp., Lincoln: Brit. J. S., 1916, iv, 186.	Bullet. Male, 31. Right.	Thrill. Swelling. Venous hum.	At operation: Aneurysmal vsrix of sup. 3rd. femoral vessels.	Quad. lig. fem. vsls. 16 days until treatment.	Cure.	Slight dilation of com. fem. art.
365	Supplee, E. A.: Bost, M. & S. J., 1916, clxxiv, 352.	Stab. Male, 47.	Thrill & bruit. Tumor size of orange. Dim. per. pulsation.	Arterio-venous aneur. of sup. 3rd. fem. vsls.	Prox. lig. art. & vein.	Cure.	
366	Swan, R. J.: Brit. J. S., 1916, iv, 174.	Bullet. Male.	Thrill, like "emphysematous crackling." Rumbling bruit.	At operation: Arterial encysted varicose aneurysm of fem. vsls. in Hunter's canal.	Extirpation. 1½ mos. until treatment.	Cure.	
367	Halsted, W. S.: J. H. H. Surg. No. 41803. Oct. 13, 1916.	Trauma? Male, 48. Right.	Leg covered with healed ulcers. Swelling of leg. Venous dil. Pulsa. Cont. thrill. Tumor size of goose egg. Machinery murmur. Thickening of int. saphenous veins.	At operation: Varicose aneur. fem. vsls. in Hunter's canal. Thrombus in sacculation on art. opposite communication.	Lateral suture of fem. artery and vein. More than 8 years until treatment.	Cure.	Aneur. of arch of aorta. Nodal extrasystolies. Prox. dil. fem. art. Calcareous material in wall of artery.
368	Horsley, J. S.: Med. & Surg., St. Louis, 1917, i, 25-29. Case 1.	Male. Left.	Signs after several mos. Thrill. Swelling. Valves of heart insufficient.	At operation: Aneursymal varix of sup. 3rd. fem. vessels.	*1st. op.* Lateral sut. art. & vein. 21 days. *2nd. op.* Lig. ext. iliac A.	Hemorr. Death from cardiac dilation.	Prox. dil. fem. art.
369	*Ibid.*, Case 2.	Shot. Fem., 14,	Signs after few weeks. Swelling. Bruit. Weakness. Diastolic murmur.	At operation: Aneurysmal varix of fem. vsls. Moderate dilation. A. & V.	Quadruple ligation.	Cure.	Prox. dil. art.
370	Halsted, W. S.: J. H. H. Surg. No. 44386, Oct. 2, 1917.	Bullet. Male, 45.	Shortness of breath. Cont. rough thrill & noise like engine. Tumor size of walnut. Loud, humming bruit. Pulsation.	Arterio-venous aneur. of sup. 3rd. fem. vessels.	No treatment.	.....	Apparent dil. fem. A. After injury: Chronic myocarditis auricular fibrillation & myocardial insufficiency.

XIII. ARTERIO-VENOUS ANEURYSMS OF POPLITEAL VESSELS

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
371	Hodgson, J.: Treatise on Diseases, etc., Lond., 1815, 496.	Shot. Male. Right.	Signs after 10 days. Tumor size of hen's egg.	Aneurysmal varix of the popliteal vessels.	1½ years until treatment. Compression.	Unknown.	
372	Porter, W. H.: Cycl. of Anat. & Physiol. 1835, i, 242.	Spont. Male.	Pulsating tumor size of child's head. Veins like twisted & knotted ropes. Peculiar thrill.	Varicose aneurysm of popliteal vessels.	14 years until examination. Patient refused treatment.	Unknown.	Lasted 14 years with little inconvenience.
373	Stromeyer, G. F. L.: Handb. der Chir., 1844, i, 776. (Bramann.)	Knife. Male.	.....	Aneurysmal varix of the popliteal vessels.	Hunterian ligation of femoral artery.	Cure.	
374	Brainard, D.: Ill. & Ind. Med. & Surg. J., 1847-48, iv, 505.	Knife. Male, 21.	Signs after 4 weeks. Thrill & venous dilation. Ulceration of leg. Pulsa. tumor.	Varicose aneur. of upper popliteal vessels. Prox. thinning & dil. poplit. A.	*1st. op.* Quad. lig. & incis. *2nd. op.* Amput. after 5 ds. 5½ years until treatment.	Suppur. & hemorr. Improvement.	
375	Cock, E.: Med. Chir. Trans., 1851, xxxiv, 327.	Stab. Male, 28.	Œdema of leg. Distinct, deep-seated fluctuation. Venous dil. Considered to be a large abscess.	Varicose aneur. of upper popliteal vsls. Central obliteration of pop. V.	*1st. op.* Prox. lig. fem. art. *2nd. op.* 11 yrs. after. Swelling lanced. *3rd. op.* Amput. above knee.	Tumor on V. fever & infection. Recovery.	Venous dil. on post. tibial lanced for an abscess.
376	Boling: Gaz. Hebd., 1858, No. 7. Bramann.	Spont. Male, 16.	Pain, swelling, tumor & murmur.	Varicose aneurysm of popliteal vessels.	Amputation of femur.	Cure.	Aneurysm caused by exostosis of tibia.
377	Heyfelder: Deuts. Kl., 1858, S. 434. Bramann.	Cut. Male, 16.	Throbbing tumor size of pigeon's egg. Œdema. Venous dilation.	Varicose aneurysm of popliteal vessels.	Compression for 21 days. 4 months until treatment.	Failure.	
378	McLean, D.: Penin, J. M., Detroit, 1874, x, 199.	Scythe. Male, 37. Left.	Tumor. Thrill. Whole leg swollen. Fem. art. appeared enlarged & pulsated.	At operation: Aneurysmal varix of upper pop. vsls. Prox. dil. fem. & pop. art.	*1st. op.* Quad. lig. *2nd. op.* Amputation. 19 years until treatment.	Gangr. 2 days aft. Death.	Gangrene after quad. lig. Prox. lig. fem. & pop. arteries.
379	Annandale, T.: Lancet, Lond., 1875, i, 568.	Punct. Male, 10.	Signs after 3 days. Pulsation swelling. Dim. per. puls. Tumor size infant's head.	Varicose aneurysm of popliteal vsls. Sac smooth on inner surface.	Quad. lig. after incision. 3 months until treatment.	Cure.	
380	Fitzgerald, T. N.: Australian M. J., 1878, xxiii, 247.	Stab. Male, 33. Left.	Pulsa. Bruit. Thrill. Pain. Numbness & throbbing. Œdema of leg. Venous dil. Dim. peripheral pulsation.	Autopsy: Varicose aneur. poplit. vsls. Prox. dil. fem. pop. & iliac arteries. Hyp. & dil. of heart.	*1st. op.* Direct compr. *2nd. op.* 5 mos. after. Hunterian lig. fem. artery. *3rd. op.* Amputation. 15½ yrs. until treatment.	Erysip. & palp. Gangrene. Death.	Prox. dil. fem., pop. & iliac art. Hyp. & dilation of heart.
381	Keyes, E. L.: Virginia Med. Mo., 1881-2, viii, 644.	Bullet. Male, 20.	Signs after 3 mos. Swelling. Expansile pulsa. Purring thrill. Dim. per. pulsa.	Autopsy: Varicose aneur. lower pop. vsls. Complete section. Sac size of goose's egg. Prox. dil. popliteal artery.	Quad. lig. & incision & tampon of coagulating material.	Death from infection.	Distal opening of art. not found. Prox. dilation pop. art.

XIII. ARTERIO-VENOUS ANEURYSMS OF POPLITEAL VESSELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
382	Reinhold, R.: Blutcyste, etc., Marburg, 1882. (Bramann.)	Knife. Male, 15.	Tumor size of apple. Venous dilation. Thrill.	At operation: Varicose aneur. poplit. vessels. Blood cyst formed from sac.	*1st. op.* Compression & forced flexion. *2nd. op.* Quad. ligation.	No result. Cure.	
383	Lucas-Championniere, J.: Bull. et mém. de la Soc. de chir., Par., 1888, xvi, 39.	Scythe. Male, 48.	Tumor. Pulsa. Cont. bruit. Thrill. Venous dilation. Prox. dil. fem. & ext. iliac arteries.	At operation: Varicose aneurysm of popliteal vessels.	Double arterial ligation.	Cure.	Prox. dilation of fem. & ext. iliac arteries.
384	Robinson, A. H.: Trans. Path. Soc., Lond., 1888, xxxix, 85.	Blow. Male, 32.	Amput. of leg 16 yrs. before. Blow on stump. Expansile pulsation. Pain.	Specimen: Varicose aneurysm of popliteal vsls. with 2 large varicosities.	Extirpation. 6 weeks until treat.	Unknown.	Communication by flap-like opening between vessels.
385	Trélat: Bull. et mém. Soc. de chir., Paris, 1889, xv, 153.	Bullet. Male, 23.	Signs after 2 weeks. Ulceration. Phlebitis. Venous dilation. Pulsation. Throbbing. Thrill. Bruit.	Specimen: Varicose aneurysm popliteal vessels. Sac 10 cm. by 13 cm. Calcareous plaques on interior surface.	Extirpation. 9 yrs. until treatment.	Cure.	Temperature of injured leg higher.
386	Curtis, B. F.: Am. J. Med. Sci., 1891, ci, 142.	Bullet. Male, 28.	Signs after 1 year. Swelling of right leg. Venous dil. & pulsa. Thrill. Murmur.	At operation: Varicose aneurysm of popl. vessels.	Extirpation. 13 years until treatment.	Cure.	
387	Curtis, B. F.: Am. J. Med. Sci., 1891, n. s., ci, 142.	Bullet. Male, 24.	Pulsating tumor 5 x 2½ in. Thrill. Murmur.	At operation: Varicose aneurysm of upper popl. vsls. Art. contracted below.	Extirpation. 9 years until treatment.	Cure.	
388	Barreno, A.: Cron. Med.-Quir. de la Habana, 1891, xvii, 571. (Monod & Vanverts.)	Male, 32.	.....	.....	Extirpation.	Cure.	
389	Menocal: In Barreno. Cron. Med.-Quir. de la Habana, 1891, xvii, 571. (Monod & Vanverts.)	Male, 35.	.....	.....	Extirpation.	Cure.	
390	Halsted, W. S.: J. H. H. Surg. No. 6560, 1897.	Bullet. Male, 34.	Expansile swelling. Continuous bruit & thrill. Venous dil. Swelling of leg.	Specimen: Varicose aneur. of upper pop. vessels of varicose encysted type. Sac. seems fibrous.	8 yrs. until treatment. *1st. op.* Hunterian lig. of femoral artery. *2nd. op.* Amput. above knee. *3rd. op.* Reamputation.	Gangrene. Gas bac. infection. Recovery.	
391	Becker, G.: Inaugural Dissertation, Halle, 1897.	Scythe. Male, 44.	Signs after 3 days. Venous dil. Contin. thrill. Dim. per. pulsa. Tumor size hen egg.	At operation: Varicose aneurysm. lower pop. vsls. Walls of vein hypertroph. Organized clot in sac.	4 days until treatment. Extirpation.	Cure.	
392	Klemm, P.: Centralbl. f. Chir., 1897, xxiv, 1181.	Bullet. Fem., 32. Left.	Loud bruit. Posterior pulses equal.	At operation: Popliteal vessels severed.	Extirpation.	Cure.	

XIII. ARTERIO-VENOUS ANEURYSMS OF POPLITEAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
393	Newbolt, G. P.: Lancet, London, 1898, i, 1116.	Piece of glass. Male, 23.	Pulsating tumor size of an orange.	At operation: Varic. aneur. of lower pop. vsls. Clot present in sac.	4 weeks until treatment. Quad. lig. & incision.	Cure.	
394	Poncet, A.: Gaz. des hôp., 1899, lxii, 587. (Monod & Vanverts.)	Cut. Male, 17.	.....	.....	Extirpation.	Cure.	
395	Lewtas, J. T.: Lancet, London, 1900, ii, 1073.	Bullet. Male. Left.	Pulsating tumor. Characteristic thrill. Pain over foot.	At operation: Varicose aneurysm of popliteal vessels.	3 mos. until treatment. Prox. lig. of artery & double ligation of vein.	Cure.	
396	Barendrecht, K. H. J.: Nederl. Tijdschr. v. Geneesk., Amst., 1902, Tweede Reeks, xxxviii, 717. (Monod & Van.)	Bayonet. Male.	.....	.....	30 years until treatment. Extirpation.	Death.	
397	v. Eiselsberg, A. F. (In C. Sprengel): Thèse d'Erlangen, 1902, Obs. 5. (Monod & Van.)	Scythe. Male, 25.	.....	.....	2 months until treat. Extirpation.	Improvement.	Residual gangrene. Foot incapacitated.
398	v. Bergmann, E.: Arch. f. Klin. Chir., 1903, lxvii, 515.	Bullet. Male, 26.	Signs after 3 weeks. Continuous thrill & bruit. Dim. per. pulsation.	Specimen: Varicose aneur. of upper popliteal vessels. Sac size hen's egg.	Quad. lig. artery & vein. Excision of the sac.	Cure.	
399	Lenger: Bull. de l'Acad. roy. de Méd. de Belgique, 1903, xvii, 1002. (Monod & Vanverts.)	Bullet. Male, 41.	.....	.....	21 years until treat. *1st. op.* Hunterian lig. femoral artery. *2nd. op.* Amputation.	Gangrene. Cure.	
400	Le Fort, R.: Bull. et mém. de la Soc. de chir., Paris, 1903, xxix, 1180. (Monod & Vanverts.)	Bullet. Male.	.....	.....	Extirpation.	Cure.	
401	Körte, W.: Verhandl d. Deutsch. Gesell. f. Chir., 1904, i, 13.	Knife. Male, 13. Right.	Signs of arterio-venous aneurysm.	At operation: Aneurysmal varix of popliteal vessels.	25 days until treatment. Lateral suture of popliteal artery & vein.	Cure.	
402	Freyer, S. F.: J. Roy. Med. Corps, 1904, ii, 558. (Case 4.)	Bullet. Male.	Swelling, pulsation, bruit & thrill. Sensory changes in foot.	.....	7 weeks until treatment. Anel's ligation of femoral artery.	Cure.	
403	Freyer, S. F.: J. Roy. Med. Corps, 1904, ii, 558. (Case 3.)	Bullet. Male.	Swelling. Thrill. Bruit.	Arterio-venous aneurysm of popliteal vessels.	Hunterian ligation of femoral artery.	Improvement.	

XIII. ARTERIO-VENOUS ANEURYSMS OF POPLITEAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
404	Wiesinger: Deutsche Med. Wchnschr., 1904, xxx, 157.	Bullet. Male, 18. Left.	Swelling. Pulsating tumor. Skin of thigh blue color. Leg tired easily.	At operation: Varicose aneurysm of popliteal vsls. inter. & encyst. variety.	Lateral suture of popliteal artery and vein.	Cure.	
405	Arrizabalaga, G.: Rev. Soc. méd. argent. Buenos Aires, 1904, xii, 185. (Monod & Vanverts.)	Bullet. 30.	.....	Arterio-venous aneurysm of popliteal vessels.	Incision and quad. ligation.	Cure.	
406	Hannecart, A.: J. de Chir. et Ann. Soc. Belg. de Chir., Brux., 1904, iv, 130.	Fall. Male, 27.	.....	Arterio-venous aneurysm of popliteal vessels.	Extirpation.	Cure.	
407	Bornhaupt, L.: Arch. f. Klin. Chir., 1905, lxxvii, 590. Obs. 16.	Wound.	.....	At operation: Aneurysmal varix of popliteal vessels.	3 months until treatment. Extirpation.	Cure.	
408	*Ibid.*, Obs. 17.	.....	.....	At operation: Varicose encysted aneurysm of pop. vessels. Sac on vein size of egg.	Extirpation.	Cure.	
409	*Ibid.*, Obs. 18.	Wound. Male.	Muscular paralysis of peroneal group. Œdema of the entire extremity.	At operation: Varicose encysted venous aneur. of lower pop. vsls. Sac size of an egg.	Extirpation.	Cure.	Nerve changes unaffected by operation.
410	*Ibid.*, Obs. 19.	Wound. Male.	.....	At operation: Varicose encysted aneurysm of pop. vessels. Tibial nerve adherent to sac.	3 months until treatment. Incomplete extirpation.	Cure.	Pain & muscular atrophy persisted after operation.
411	Valat: Bull. méd., 1905, xix, 13.	Wound. Male, 52.	.....	Arterio-venous aneurysm of popliteal vessels.	2 months until treatment. Quadruple ligation.	Cure.	
412	Saigo, K.: Deutsche Ztschr. f. Chir., 1906, lxxxv, 577. (Obs. 32.)	Bullet. Male, 24.	.....	At operation: Varicose encysted arterial aneur. of popliteal vessels. Sac size of an egg.	75 days until treatment. *1st. op.* Compression. *2nd. op.* Extirpation.	Failure. Cure.	
413	*Ibid.*, Obs. 33.	Bullet. 26.	.....	At operation: Varicose encysted intermediate aneurysm of pop. vessels.	4 months until treatment. Extirpation.	Cure.	
414	Cranwell, J.: Rev. de chir., 1906, xxxiv, 817.	Knife. Male, 21.	Serious signs after 3 years. Ulceration. Swelling of leg. Continuous thrill & bruit.	At operation: Aneurysmal varix of popliteal vsls.	6 years until treatment. Ligature of channel of communication.	Cure.	
415	v. Frisch, O.: Arch. f. Klin. Chir., 1906, lxxix, 515. (Case 2.)	Stab. Male, 8. Right.	Signs after 1 month. Swelling. Pulsating tumor. Continuous thrill & bruit.	At operation: Varicose aneurysm of popliteal vsls. Fistula 1 cm. x 2 mm.	8 weeks until treatment. Extirpation.	Cure.	
416	*Ibid.*, Case 3.	Scythe. Male, 20. Right.	Pulsating tumor size of an apple. Ulceration. Bruit & thrill. Swelling of leg.	At operation: Varicose aneur. of popliteal vsls.	4½ years until treatment. Extirpation.	Cure.	

XIII. ARTERIO-VENOUS ANEURYSMS OF POPLITEAL VESSELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
417	*Ibid.*, Case 10.	Spont. Male, 20. Right.	Ulceration. Outspoken varicosity of thigh. Severe pain. Swelling of right thigh.	Specimen: Aneurysmal varix of pop. vsls. Small saphenous vein thickened and tortuous.	16 years until treatment. *1st. op.* Hunterian lig. of femoral artery. *2nd. op.* Amput. at thigh.	Gangrene. Recovery.	Prox. thinng & dilation of femoral artery.
418	Lexer: Arch. f. Chir., 1907, lxxxiii, 459. (Monod & Vanverts.)	Knife. Male, 34.	.....	At operation: Arterial & venous encysted varicose aneur. of pop. vessels.	31 days until treatment. Extirpation. End to end sut. of art. & vein over magnesium tubes.	Cure.	
419	Ochmann, A. A.: Russk. Vratch, St. Peterb., 1908, p. 1350. (Monod & Vanverts.)	.....	.....	Arterio-venous aneurysm of popliteal vessels.	Quadruple ligation and incision.	Cure.	Residual plaques of gangrene of toes.
420	Ochmann, A. A.: Russk. Vratch., St. Peterb., 1908, 1350. (Obs. 8.) (Monod & Van.)	Bullet.	.....	Arterio-venous aneurysm of popliteal vessels.	Extirpation. 10 cms. of each vessel removed.	Cure.	Residual contracture of the knee.
421	Garrè, C.: Deutsche Ztschr. f. Chir., Leipzig (R. Stich), 1908, xcv, 577. (Mon. & V.)	Missile. Male, 17.	.....	At operation: Arterial encysted varicose aneur. of popliteal vessels.	Extirpation & end to end suture of artery.	Cure.	
422	Sabadini: Bull. méd. de l'Algerie, 1908, xix, 394. (Monod & Vanverts.)	Knife. Male, 19.	.....	At operation: Varicose encysted venous aneurysm of popliteal vessels.	Lateral ligature of artery & vein.	Cure.	
423	Fresno y Bastiony: Rev. de Med. y Ciruj. de la Habana, 1908, xiii, 406. (M. & V.)	.....	.....	Arterio-venous aneurysm of popliteal vessels.	Extirpation.	Cure.	
424	Da Costa, J. C.: Ann. Surg., 1912, lv, 593.	Bullet. Fem., 29.	Signs after a few hrs. Pulsation. Contin. thrill & murmur. Superficial veins varicose. Dim. per. pulsation.	At operation: Aneurysmal varix of popliteal vsls. Distal thickening & dil. of popliteal vein.	3 months until treatment. Suture of art. Resection of in. of vein & end to end anastomosis.	Cure.	Proximal dilation of femoral artery.
425	Fergusson, W. M.: Lancet, Lond., 1914, i, 532.	Cut. Fem., 2½.	Pain in knee. Swelling. Superficial veins varicose.	At operation: Varicose aneurysm of upper popliteal vessels. Sac size of turkey's egg.	Prox. ligation pop. artery. Distal ligation of vein. Partial extirpation.	Cure.	
426	Connell, E.: Brit. M. J., 1915, ii, 326.	Bullet. Male.	Pain & swelling. Pulsation. Leg bluish. Thrill & bruit.	At operation: Varicose aneurysm of pop. vessels. Sac size of hen's egg.	7 months until treatment. Incision and double ligation of artery.	Recovery.	
427	Duval, P.: Bull. Soc. de chir., Paris, 1915, xli, 460.	Bullet. Male.	.....	At operation: Aneurysmal varix of popliteal vsls.	Extirpation.	Cure.	

XIII. ARTERIO-VENOUS ANEURYSMS OF POPLITEAL VESSELS.—Continued

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
428	Wright, G. A.: Lancet, Lond., 1915, ii, 1289.	Bullet. Male, 24.	Signs after 10 days. Pain. Pulsating fullness. Thrill.	At operation: Varicose encysted venous aneurysm of popliteal vessels.	25 days until treatment. Double arterial ligation.	Cure.	
429	Cauchois: Bull. Soc. de chir., Paris, 1915, xli, 757.	Bullet. Male. Right.	Numbness & pulsation.	Arterial encysted varicose aneurysm of lower popliteal vessels & anterior tibial artery & peroneal artery.	4 months until treatment. Extirpation.	Cure.	Marked distal dilation of anterior tibial artery.
430	Case from 2d Northern Gen. Hospital: Brit. J. S., 1915-16, iii, 315.	Male, 20.	Swelling. Murmur. Machinery bruit. Pulsation. Thrill.	At operation: Venous encysted varicose aneurysm of lower popliteal vsls.	1 month until treatment. Extirpation.	Cure.	
431	Roberts, Capt. C.: Brit. J. S., 1915-16, iii, 323.	Bullet. Male, 22. Right.	Signs after 10 days. Bruit. Usual signs of aneurysmal varix.	At operation: Aneurysmal varix of popliteal vsls. Marked dilation of vein.	1 month until treatment. Double arterial ligation.	Cure.	
432	Burgess, Maj. A. H.: Brit. J. S., 1915-16, iii, 320.	Bullet. Male, 29. Left.	Firm swelling size of cocoanut.	At operation: Aneurysmal varix of lower popliteal vessels.	Quadruple ligation.	Cure.	
433	*Idem:* Brit. J. S., 1915-16, iii, 321.	Shrapnel. Male, 26. Left.	Swelling of leg. Dilation of superficial veins. Tumor size of walnut. Thrill.	Aneurysmal varix of popliteal vessels.	.....	.....	Bruit of the "fly-in-paper-box" variety.
434	*Idem:* Brit. J. S., 1915-16, iii, 322.	Bullet. Male, 20. Left.	Signs after 11 days. Throbbing pain. Sac size hen's egg. Swelling, pulsation, thrill & bruit.	At operation: Venous encysted varicose aneurysm of upper popliteal vsls.	20 days until treatment. Quadruple ligation.	Cure.	

XIV. ARTERIO-VENOUS ANEURYSMS OF BRANCHES OF POPLITEAL VESSELS

435	Gross, S. W.: Proc. Path. Soc., Phila., 1867, ii, 86.	Spont. Fem., 43. Left.	Nævus maternus on back of foot. Thrill, bruit & dil. of vessels. Ulceration.	At operation: Aneurysmal varix of leg & foot.	Amputation below knee.	Death.	Prox. dil. posterior tibial artery.
436	Annandale, T.: Lancet, Lond., 1876, ii, 531.	Trauma. Male, 20. Right.	Signs after a few days. Swelling. Pulsation. Thrill. Tumor size of walnut.	At operation: Varicose aneurysm of posterior tibial artery & vein.	Compression. After 6 weeks, quadruple ligation post. tib. art. & V.	Failure. Cure.	Aerial transmission of murmur.
437	Faguet: Bull. de la Soc. d'Anat. et de Physiol. normales et pathol., 1892, xlii, 56.	Scythe. Male, 26. Left.	Signs after 10 days. Pain & pulsation. Contin. bruit & thrill. Tumor size of small nut.	Specimen: Varicose aneur. of peroneal artery & vein.	16 days until treatment. *1st. op.* Double lig. of posterior tibial artery. *2nd. op.* Extirpation of aneur. of peroneal art. & V.	Failure. Cure.	Prox. dilation of peroneal artery. Case difficult of diagnosis.
438	Annequin: Arch. de méd. et pharm. milit Par., 1893, xxi, 259. (Monod & Vanverts.)	Bullet. Male.	.....	Arterio-venous aneurysm of posterior tibial vessels.	Compression. Extirpation.	Failure. Cure.	

XIV. ARTERIO-VENOUS ANEURYSMS OF BRANCHES OF POPLITEAL VESSELS.—CONTINUED

No. of Case	Author and Publication	Cause, Sex, Age, Side	Symptomatology	Type of Aneurysm, Location, Description of Fistula	Treatment	Result	Comment
439	Secheyron & Desforges-Mériel, E.: Arch. méd. de Toul., 1899, v, 85. (Monod & Vanverts.)	Cut.	.....	At operation: Intermediate encysted varicose aneur. of posterior tibial vsls.	Extirpation.	Cure.	
440	Damas: Gaz. de méd. et de chir., 1899, n. s., iv, 205. (Monod & Vanverts.)	Wound. Male, 24.	.....	At operation: Arterial encysted varicose aneur. of posterior tibial vsls.	Extirpation.	Cure.	
441	Jaboulay, M. (in C. Viannay): Arch. prov. de chir., 1901, x, 459. (Monod & Vanverts.)	Bullet. Male, 27.	.....	Arterio-venous aneurysm of posterior tibial vsls.	4 months until treatment. *1st. op.* Extirpation. *2nd. op.* Hunterian lig. of femoral artery. *3rd. op.* Amput. at foot.	Hemorr. Gangr. in foot. Recovery.	Nerves adherent.
442	Schwartz, Ed.: Bull. et Mém. de la Soc. de chir., 1901, xxxvii, 820. (Monod & Vanverts.)	Knife. 17.	.....	At operation: Aneurysmal varix of superior anterior tibial vessels.	Compression. 7 months. Extirpation.	Failure. Cure.	
443	Treves, Sir F.: Brit. M. J., 1902, i, 1135.	Bullet. Male, 21.	Signs after 22 days. Knee stiff & wasted. Pulsation, buzzing bruit & harsh thrl. Sac size of walnut.	At operation: Varicose aneurysm of upper post. tibial vessels & ant. tibial vein.	11 weeks until treatment. Quad. lig. post. tib. art. & vein. Double lig. of ant. tibial vein.	Cure.	
444	Gross, G., et Sencert, L.: Rev. méd. de l'Est, 1906, xxxviii, 383. (Monod & Vanverts.)	Fracture. Male, 60.	.....	At operation: Arterial encysted varicose aneur. of anterior tibial vsls.	2½ months until treatment. Extirpation.	Cure.	
445	Lambotte, A.: J. de chir. et Ann. de Soc. Belge. de chir., 1906, vi, 105. (Monod & Vanverts.)	Bullet. Male, 50.	.....	Arterio-venous aneurysm of posterior tibial vsls.	Extirpation.	Cure.	
446	Ray, Major J.: Brit. J. S., 1915-16, iii, 324.	Bullet. Male, 23. Right.	Signs 1 month later. Pulsation. Swelling. Purring thrill.	At operation: Varicose aneurysm of anterior tibial vessels.	2 months until treatment. Incision of sac and lateral suture of art. & V.	Cure.	
447	Turner, Maj. G. G.: Brit. J. S., 1915-16, iii, 289.	Bullet. Male, 36. Left.	Swelling left leg. Thrill. Purring bruit. Foot dusky color. Dim. per. pulsation.	At operation: Varicose aneur. post. tib. vsls. & varicose aneur. per. vsls.	3½ months until treatment. Extirpation.	Cure.	Two aneurysms in same person.

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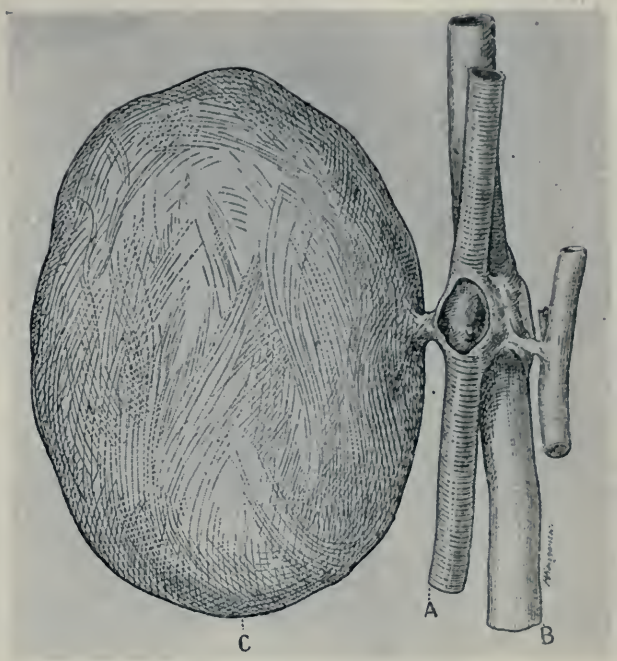

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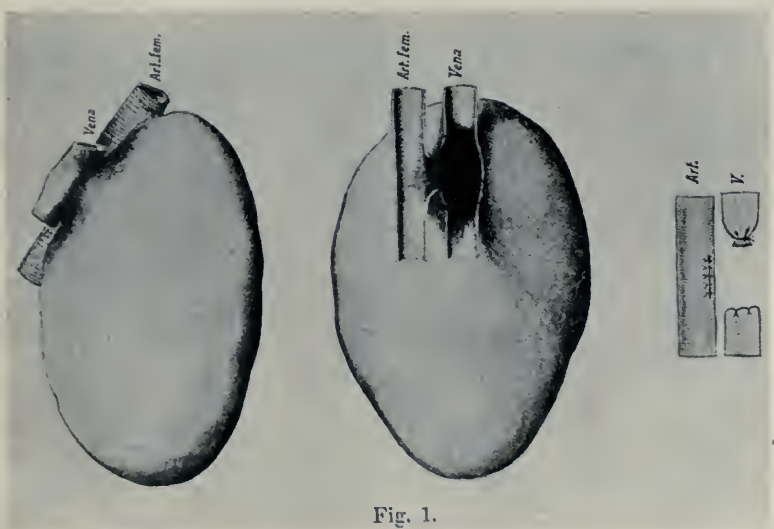

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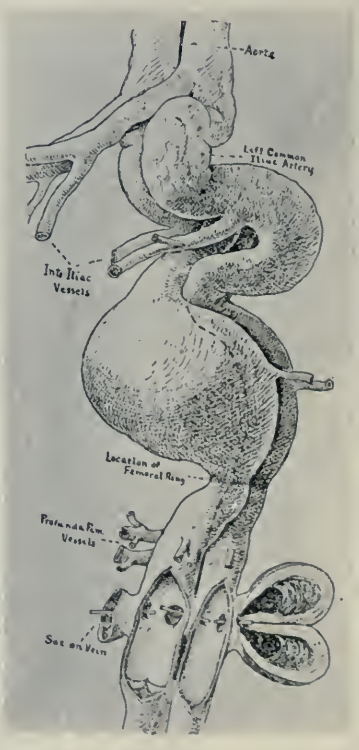

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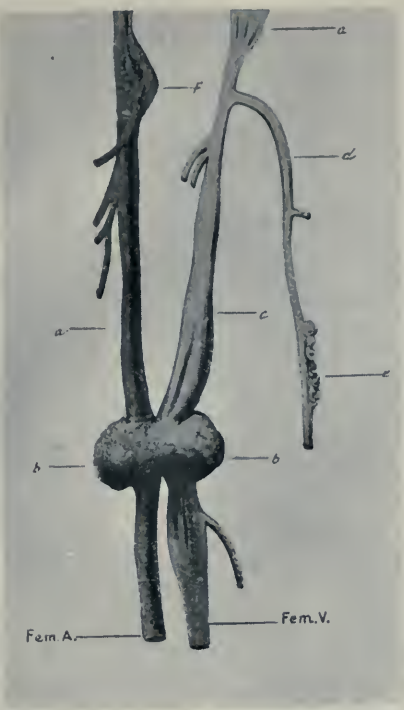

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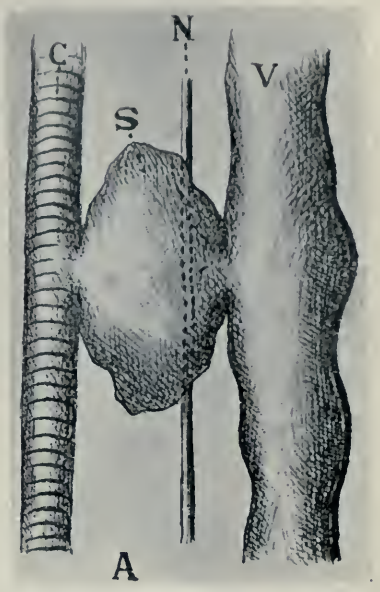

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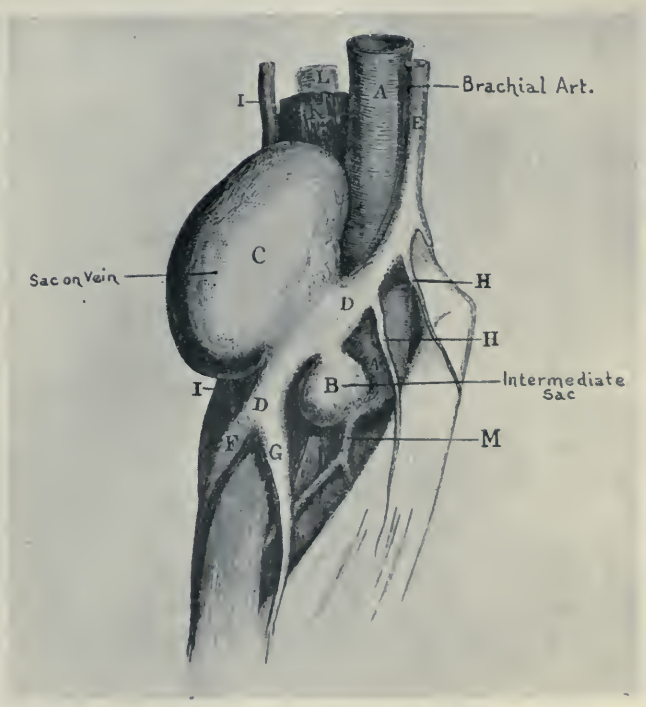

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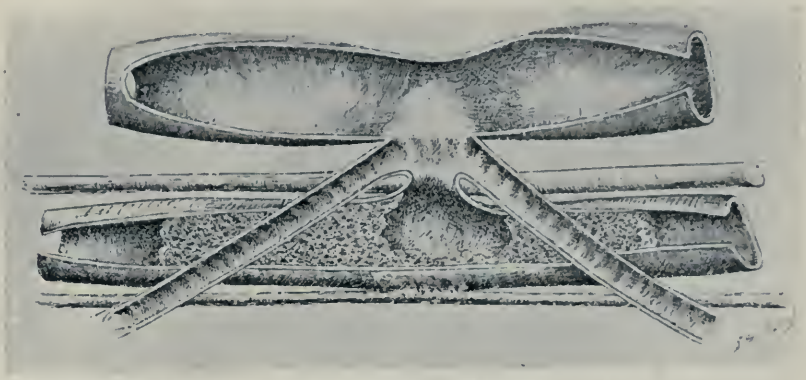

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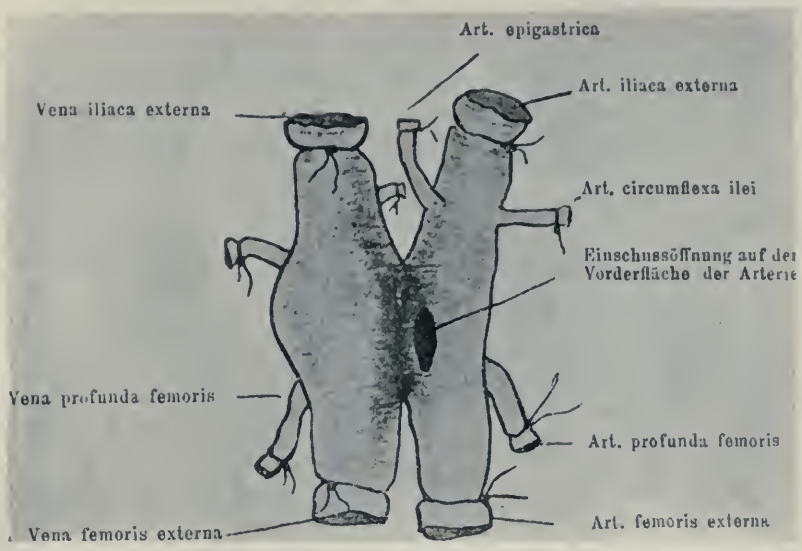

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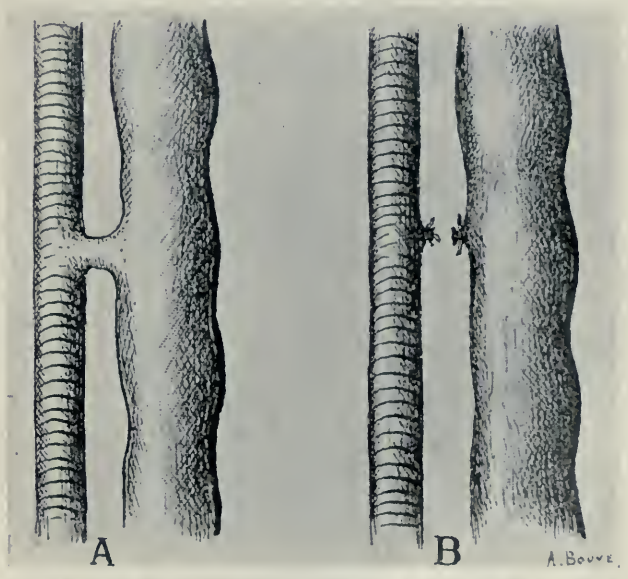

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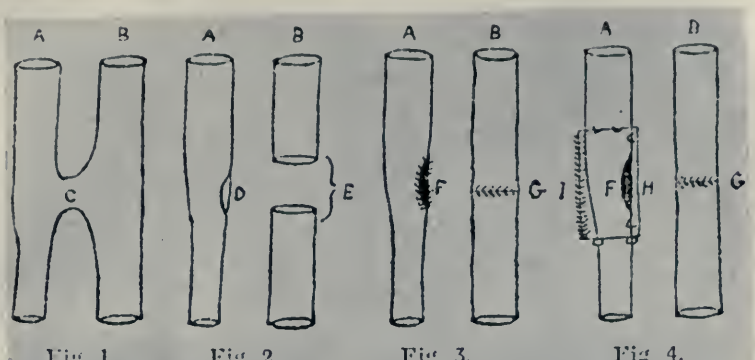
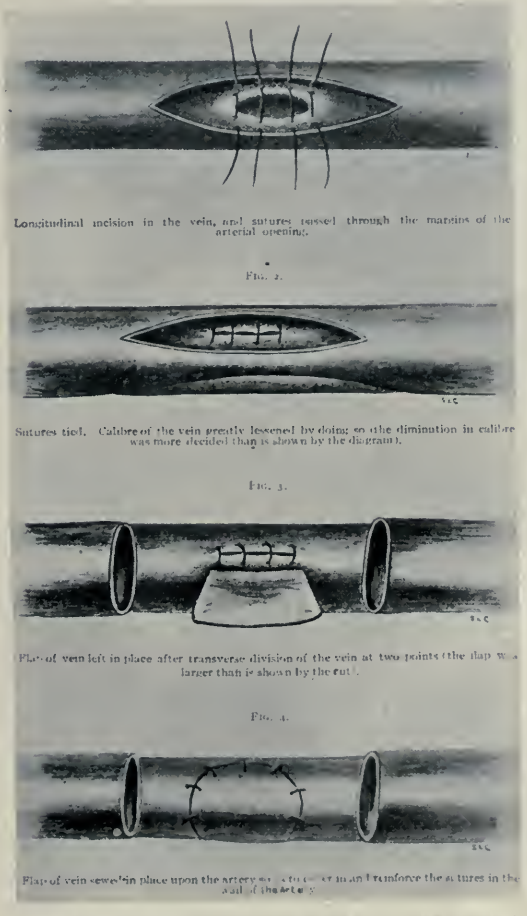


Fig. 1. Fig. 2. Fig. 3. Fig 4.

A, Artery. B, Vein. C, Communication between artery and vein. D, Hole in artery after dissecting out communication and refreshing edges. E, The two ends of the vein ready for end-to-end anastomosis, the dilated portion having been cut away in order to get healthy vein tissues for anastomosis. F, Artery sutured laterally with fine silk sutures. G, Vein sutured, end-to-end anastomosis. H, Graft from internal saphenous vein surrounding the sutured artery, and sutured on opposite side to sutured artery at I.

Lateral suture and reinforcement of artery and end-to-end suture of vein in aneurysmal varix of the femoral vessels. Godwin: Brit. Med. J., 1915, ii, 925.



Longitudinal incision in the vein, and sutures passed through the margins of the arterial opening.

Fig. 2.

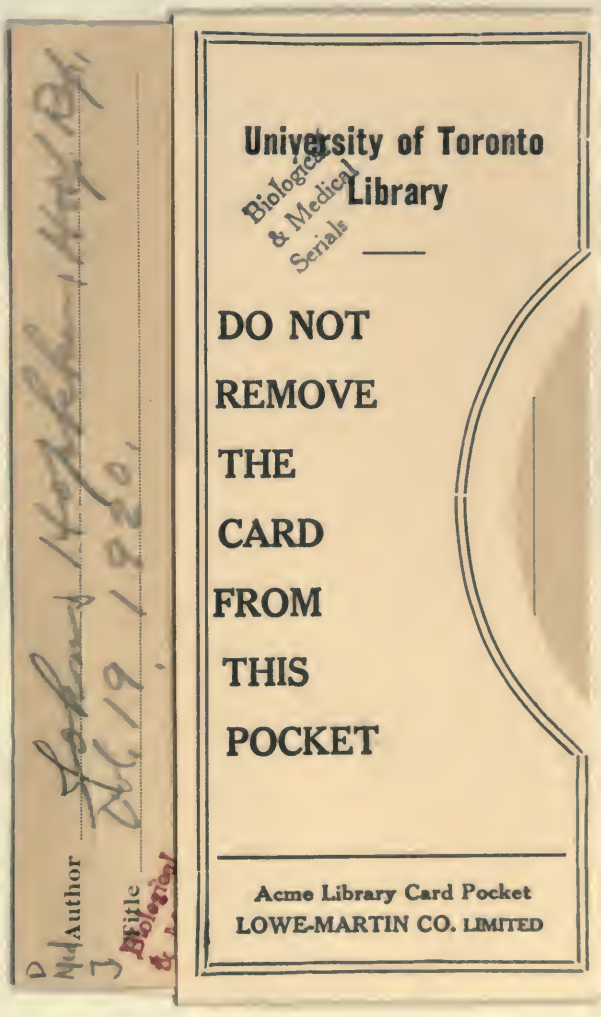
Sutures tied. Calibre of the vein greatly lessened by doing so (the diminution in calibre was more decided than is shown by the diagram).

Fig. 3.

Flap of vein left in place after transverse division of the vein at two points (the flap was larger than is shown by the cut).

Fig. 4.

Flap of vein sewed in place upon the artery so as to cover in and reinforce the sutures in the wall of the artery.

Lateral reinforced suture of the artery, with resection and end-to-end suture of the vein in popliteal varix. da Costa: Ann. Surg., 1912, iv, 593.

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